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Reports on Current European/Middle Eastern Science

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The European Science Notes Information Bulletin (ESNIB) is a compilation of reports on recent developments in European science of specific interest to the US R&D community, and is issued in support of the mission of the Office of Naval Research Branch Office, London. It is not intended to be part of the scientific literature. The value of the Bulletin to Americans is to call attention to current activity in European science and technology and to identify the institutions and people responsible for these efforts. ESNIB authors are primarily ONRL staff members; other reports are prepared by or in cooperation with staff members of the USAF European Office of Aerospace Research and Development or the US Army Research, Development and Standardization Group. US scientists travelling in Europe may also be invited to submit reports.

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This publication is approved for official dissemination of technical and scientific information of interest to the Defense research community and the scientific community at large

Commanding Officer ..... CAPT Terry J. McCloskey, USN
Scientific Director ..... James E. Andrews
Editor ..... C.J. Fox

EMBASSY PERSPECTIVES

This article is comprised of contributions by Patricia Haigh, Allen Lee Sessoms, Gerald J. Whitman, James B. Devine, Edward M. Malloy, Ishmael Lara, Anthony Rock, Francis X. Cunningham, and Ronald K. Kirkpatrick. The contributions, in general, provide overviews of R&D policy, budgets, and government institutions of the various countries they concern.

BEHAVIORAL SCIENCES

Research at the University of Naples, Italy, by Giacomo Iacono in the psychology of post pacemaker implantation is reviewed. Of particular interest is the dependence on continuity of the personal physician's care, and their need (showed by the doctors) to gain a sense of personal control over the maintenance process.

Dr. Stefan Hormuth, University of Heidleberg, West Germany, gives an overview of his research on the impact of frequent relocation on families and the individuals subject to such experience.

BIOLOGICAL SCIENCES

The imaging method developed at Haslar Royal Naval Hospital, Portsmouth, UK, affords the opportunity of observing *in vivo* cerebral lesions following insult due to dysbaric-related accidents. It is a potential tool for studying diving casualties and gaining new insights into the pathology involved and the optimal treatment protocols as well as for examining the long-term neurologic effects of diving injuries.

COMPUTER SCIENCES

The artificial intelligence group at the University of Santiago in Northern Spain is doing prominent research in both basic theory and applications. This article reviews their work on the integration of artificial perception and action. Intersensorial communication and lesion-tolerant and multiprocessor systems are also mentioned.

CONTROL SYSTEMS

Work at INRIA's Sophia-Antipolis center is discussed. Topics are: programmation, symbolic calculus, and artificial intelligence; networks and distributed systems; control, production, and treatment of signals and data; robotics, image and vision; scientific calculation, numerical codes, computer assisted engineering; and man-machine communications.

Controls research done by Dr. R.J. Patton and his group is discussed. The author says that this group is doing some of the best work in eigenstructure methods that he has seen in Europe.

FLUID MECHANICS

Research at the Lehrstuhl für Stromungsmechanik (LSTM) at West Germany's University of Erlangen-Nurnberg, is reviewed. Topics are: fluid flow measuring systems, experimental fluid mechanics, computational fluid mechanics, two-phase flows, rheology, and flows with chemical reactions.

MATHEMATICS

Research in theoretical mathematics at the Weizmann Institute reviewed in this article concerns mathematical economics, operator or estimation theory, and control and optimization. The work in applied mathematics includes studies in feedback systems, fluid mechanics, and theoretical biology.

PHYSICS

At the new, small Physics Department of the University of Oviedo, Northern Spain, an enthusiastic and experienced group of scientists persues high-quality research in magnetic materials. In particular, magnetic ribbons and films, as well as amorphous magnetic materials in bulk, are the focus of interest. Various high-sensitivity magnetometers have also been developed.

A general overview of the Laser Technologies in Industry conference (Oporto, Portugal) is followed by a few comments on contributions to topics on optical metrology/sensing, and holography.

"Optoelectronics: 1990 and Beyond" was a medium sized, by-invitation-only, international meeting in Ireland One day of the program was devoted to the technology of optoelectronic devices; this article reviews some of the presentations.

SENSORS

Sensor '88, a West German sponsored, large exhibition and conference, presented a good insight into the status of European sensorics. This article gives brief summaries of selected talks on new methods, chemical sensors, pressure measurement, optical sensors and optical techniques.

SPACE SCIENCE

Presentations given at this conference, held in April 1988 in London, UK, are discussed under the topics of: system design, control, and networking; antennas; noise, interference, and modeling; propagation; RF equipment and techniques; HF radar; and signal design and processing. The author concludes the HF as an RF band is not obsolete, and that new developments are leading to new perceptions of RF.

The conference was held in July 1988 at Cambridge, UK. Reviews of American, Western European, Russian, and Japanese auroral research programs and plans are given.

SUPERCONDUCTIVITY

A major problem hindering rapid application of new high critical temperature superconductors, is their inability to carry adequate amounts of electrical current. This conference, held in May 1988 at Birmingham, UK, concerned that problem. The discussions and presentations are reviewed.

High values of the critical current density (J_c) for polycrystalline films were reported at a workshop held in May 1988 at the University of Birmingham. This note gives the essential facts.

NEWS, NOTES, AND ABSTRACTS

EMBASSY PERSPECTIVES

In April 1988 the Office of Naval Research, London sponsored a meeting in London of the US Science Counselors from Western Europe and the Middle East, the National Science Foundation European representative, the NASA European representative, the head of the Foreign Broadcast Information Office (FBIS) in Antwerp, and the ONRL professional staff. The goal of the meeting was an increase in communication and exchange of information between these offices on the state of science and technology in Europe. While ONRL is a unique resource in reporting on science and technology from the perspective of peers in specific scientific fields, it cannot report on the entire range of scientific activity in Europe either technically or logistically. The Science Counselors of the Department of State have a broad charter to report on science and technology policy, management and investment, and selected technical specifics in their countries. In addition, counselors at the missions to the European Economic Community (EEC) and the Organization for Economic Cooperation and Development (OECD) report on policy and program developments within these communities. The focus of the April meeting was on achieving a broader knowledge base, and providing for an expanded, and at the same time intimate, level of reporting and evaluation.

Among the issues which are of concern for European science and technology policy is the fact that the European science and technology policy is moving irregularly but inexorably towards the status of a Europe without frontiers in 1992. In this process the Community governing bodies are displaying growing power, authority, and resources which are reaching into all aspects of Community life. One important aspect has been the creation of a variety of scientific programs within the Community which fund cooperative efforts among member state institutions and scientists. Among these are ESPRITE, BRITE, and RACE, with new programs approved in environmental and marine sciences.

This issue of ESNIB presents a feature article which profiles science and technology policy and practice as reported by the embassies and missions, and in so doing provides a framework within which to view ONRL reporting from those countries. In an earlier issue of the Bulletin, ONRL began the incorporation of Science Counselor technical reports, and this will continue so that readers of the ESNIB have an enhanced perspective on European science. This issue, by coincidence, contains an unusually large number of these technical reports – all under the general heading, The Embassies: Technical Roundup.

James E. Andrews
Scientific Director

Science Counsellor posts are located at the following embassies and missions:

Paris, France	Bonn, Federal Republic of Germany
Madrid, Spain	Rome, Italy
London, UK	Athens, Greece
Ankara, Turkey	Tel Aviv, Israel
Cairo, Egypt	

US Mission to the European Economic Community, Brussels
US Mission to the Organization for Economic Cooperation and Development, Paris

Offices of the Foreign Broadcast Information Service located in Antwerp, Belgium, and Milan, Italy provide translations of items from European language data bases.

European-Middle Eastern Science and Technology–Observations by US Embassy Science Counselors and US Missions

Research and Development in the European Community

Patricia Haigh, US Mission to the European Community, Brussels, Belgium.

The European Community (EC) was formed in 1957. At present, there are 12 member states – the original six (Belgium, France, Germany, Italy, Luxembourg, and the Netherlands), plus Denmark, Ireland, Greece, Portugal, Spain, and the United Kingdom. Initiatives in research and development, as in other areas, are carried out by the EC Commission in coordination with and following approval by the member states (through the Council of Ministers) as well as in cooperation with the European Parliament.

Although the EC's major focus is on economic trade and agricultural issues, research and development is playing an increasingly prominent role. One force pushing for an augmented role is the commitment by the member states to a "single market" by 1992 – i.e., a commitment to the free movement of goods and services, capital, and persons across national boundaries. Although the focus of the efforts on the single market is on issues such as common industrial standards and harmonized tax systems, the Commission believes that increased EC-sponsored R&D efforts would enhance the ability of firms to take full advantage of the internal market. Another force is a perceived decline in Europe's competitiveness in new and emerging technologies. The EC hopes that an increase in joint R&D efforts might help to reverse this trend.

Within the Commission, three (of the 22) Directorates-General have the lead on almost all R&D projects – the Directorates-General for Science, Research and Development (DG-XII); for Telecommunications, Information Industries and Innovation (DG-XIII); and for Environment, Consumer Protection and Nuclear Safety (DG-XI). The EC Joint Research Centers (JRC) (outlined below) fall under the responsibility of the Directorate-General for Science, Research and Development.

The EC recently published its second 5-year *Framework Program for Research and Technological Development* (for 1987-1991), which will form the basis of its R&D programs during that period. Funding for the framework program is approximately $6.58 billion for the 5 years. Major areas of the program are as follows (with percent of funding):

- Information technologies, telecommunications, and transport (42.2)
- Energy (nuclear and non-nuclear) (21.8)
- Industrial technologies (including advanced materials) (15.6)
- Health and environment (6.9)
- Improvement of European cooperation in science and technology (5.3)
- Biotechnology and agro-industrial technologies (5.2)
- Science and technology for development (1.5)
- Marine science and fisheries (1.5).

Under the various projects to be initiated, approximately 84 percent of the funds will be allocated by the EC to national laboratories, private sector research centers, and university labs in the various member states. Thirteen percent will be allocated to the Joint Research Centers, and three percent will be for "concerted action programs" (which the EC only coordinates among participating member states).

The "flagship" program of the EC, and probably the best known, is the highly successful European Strategic Program for Research and Development in Information Technologies (ESPRIT). A 5-year second phase of ESPRIT, known as ESPRIT 2, was recently approved by the Council of Ministers. The EC will be funding 50 percent of this $3.8 billion program. ESPRIT research partners will fund the other half. Drawing on research conducted under ESPRIT I, this phase will continue to focus on high technology at the precompetitive level and will increase the emphasis on information technology and technology transfer within the EC. Like some other EC programs, ESPRIT is aimed at enhancing the competitiveness of European industry internationally.

The Commission operates four Joint Research Centers (JRC) – in Belgium (at Geel), the Netherlands (Petten), Germany (Karlsruhe), and Italy (Ispra). The Ispra facility is by far the largest, employing about three-quarters of the JRC's total staff. Established under the 1957 Euratom Treaty, the JRC initially was involved almost exclusively in nuclear research. Over the years, other research projects have been developed, notably in environment research, the use of satellites for agricultu-

ral purposes, and the study of non-nuclear energy sources.

In the last few years, the JRC has come under increasing criticism – from member state governments, European industry, and parts of the Commission. The thrust of the criticisms is that much of the research performed by the JRC's is unnecessary, not responsive to the needs of industry, and too expensive. The Commission currently is addressing these issues and may well make proposals on an accelerated move into areas more directly supporting the needs of industry, improved linkages with member state national laboratories, management structure, and personnel policies. Final agreement has not yet been reached.

Along with 19 European countries, the EC is a member of EUREKA, a much-heralded program which promotes joint ventures in new technologies between private sector companies in two or more countries. However, since the EC (as an institution) does not have a private sector, its role in the EUREKA program is muted.

The role of R&D within the Community has evolved. The Joint Research Center has expanded its horizons. Certain programs in high-technology areas, such as ESPRIT, have flourished. This has not been easy. The Community has had to convince the member states of its ability to organize and execute programs and overcome occasional bouts of nationalism. Yet this evolution continues. The Community wants to continue to reach out and work with the member states to expand and ensure the relevancy of current programs, as well as establish new ones.

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Of interest and relevance to Patricia Haigh's contribution is the following, taken from another source.

EC Research Council Meeting, April 11: The Results. EC Research Ministers, meeting in Luxembourg April 11, gave a formal go-ahead to the second phase of ESPRIT. They also approved joint research schemes for road safety, the use of new technologies in education, applied meteorology, and biotechnology, as well as a plan to stimulate exchanges between EC researchers. All the projects are part of the Community Framework program.

Launching of ESPRIT II. The Council formally approved the second and largest phase of the European research and development program in the field of information technology (REFTEL). Under this program, presented by the EC Commission as "the flagship of the Community's research programs," companies and universities can submit proposals for specific research projects and win EC funding for half of their cost. ESPRIT II was established for a period of 5 years, beginning 1 December 1987, with an EC budgetary allocation of 1.6 billion ECU (about $1.97 billion [1 ECU = $1.25]). According to a press statement, it will involve some 5500 researchers and at its peak will represent about 30 percent of all European precompetitive R&D in information technology.

Discussion at this Council was limited to solving a sensitive managerial problem. To the Commission's displeasure, it will now be possible for member state delegations (by majority vote) to block Commission decisions in the Management and Consultative Committee, which assists the Commission in its management of the ESPRIT program.

New Research Initiatives. The Council adopted "common positions" on the following research programs, which still require approval from the European Parliament:

- DRIVE: A 60 million ECU, 3-year program of collaborative R&D in the area of information technology and applied telecommunications in road transport
- The pilot phase of DELTA (Development of European Learning Through Technological Advance); a Community program in the area of applying new technologies to education (24 months; 20 million ECU)
- SCIENCE: An initiative by the Commission to end the brain-drain and provide for financial support (167 million ECU over 5 years) to promote international cooperation and exchanges between European researchers
- A program on applied meteorology and chemical analyses: estimated funding amounts of 59.2 million ECU for the years 1988-1992
- The revision of the multiannual action program of the EC in the area of biotechnology; to extend and intensify EC research activities in this field, ministers agreed to raise funding from 55 million ECU to 75 million ECU over the period 1985-1989.

Future Role of the EC's Joint Research Center. Pending the submission of new proposals by the Commission, discussion was limited to key issues related to the reform of the EC's Joint Research Center (JRC); issues include a new role for the Central Administration Board, staff policy, and financial aspects. The Council managed to define a financial framework of JRC activities for the period 1988-1991. According to a Commission spokesman, 700 million ECU will be funded by the EC research budget and 250 million ECU by contract partners.

Thermonuclear Fusion. Member state delegations remain split over spending for the EC research program on controlled thermonuclear fusion for the period 1987-

1991. The total amount of funding to be allocated to this program (991 million ECU) is not in question. However, opinions differ on the proposal that certain credits not be issued until 1992, although they are included in the 1987-1991 program.

Other Topics. At the initiative of the West German Council Presidency (Research Minister Reisenhuber), the Ministers also exchanged views on:

- Relations between the EUREKA program and Community research policy.
- Norms and standards: The Germans underlined the necessity of creating common EC standards for new products at the development stage. According to the final press communique, the Commission was invited to submit a communication "with its reflections in this matter."
- Bioethics: A seminar was held in Brussels to study the various ethical aspects of biotechnology and genetic research.

France

Allen Lee Sessoms, Science Counselor, US Embassy, Paris.

France views itself as a leader in Europe in Science and Technology. In fact, France is at the forefront of those leading Europe into the 21st century in major technology areas. Thus reporting resources are essential in France. Embassy Paris is fortunate in having, as part of its Science Section, an enhanced reporting capability through the European representatives for NASA and the National Science Foundation (NSF). The NASA representative, James Zimmerman, and the NSF representative, Pat Johnson, are mobile (they have their own travel budgets) and are conversant in the broader European scene. This gives the Paris Science Section the unique opportunity to be knowledgeable in matters concerning science and technology across all of Europe.

The French like to cooperate with the US. A recent European Community survey recorded that 48 percent of all active French scientists have continuing cooperative programs with American colleagues. This is twice the rate for French cooperation with their nearest major neighbors, the UK and West Germany.

Major areas of excellence in France are:

- Space. This includes the Ariane launcher, SPOT satellites, the European Space Agency (where France is the leading contributor), and military space programs such as Helios (remote sensing) and Syracuse (telecommunications).
- Nuclear energy. France is a nuclear weapons state. In addition, France produces about 75 percent of its electricity from nuclear energy.
- Health research. In AIDS research, the Pasteur Institute is first rank in the world. In immunology, Pasteur, the Merieux Institute in Lyon, and other French institutions are world leaders.
- Telecommunications. France has one of the most advanced telecommunications systems in the world. This has been a major advance during the past decade.
- Transportation. France's fast train (Train a Grande Vitesse, or TGV) is one of the world's most advanced.
- Advanced electronics, including computer sciences. Software and artificial intelligence applications are very strong.
- Oceanography, especially deep-sea submersibles: The major organizations in this area have the acronyms IFREMER (the Institute for Research and Exploitation of the Sea) and ONERA (French Aerospace Research Institute).
- Basic Sciences, such as high energy physics, chemistry, biological sciences, biotechnology, atomic physics, materials sciences.

The French also have led Europe into cooperative programs such as EUREKA, ESPRIT, RACE, and BRITE.

As a nuclear weapons state, France is particularly well placed to contribute to joint military research and development efforts. US/French cooperation in military research, in both conventional and nonconventional areas is robust and growing.

In science policy areas the US and France, have significant and ongoing dialogues on preventing the spread of nu lear weapons and on strategic export controls. In this regard I should note the close cooperation between the science section and other elements of Embassy Paris, in particular the Office of Defense Cooperation (ODC) and the Defense Attaché's Office (DAO).

The Ministry of Defense is advocating more cooperative R&D with the US. This is a trend which we strongly encourage.

The French system does have its problems. Recent reports highlight the difficulties with the educational system. The universities (such as the Sorbonne) have been, for almost 50 years, step-children, as compared to the very prestigious "Grandes Ecoles" (such as Ecole Polytechnique). This must change if France is to maintain its preeminent place in European science and technology into the 21st century.

Italy

Gerald J. Whitman, Science Counselor, US Embassy, Rome.

There is a general perception in the US and Europe that Italy is not a major player in science and technology. That perception may have been closer to reality a decade ago, but today Italy is a leader in many areas of research and development. This progress reflects the consensus of successive governments that research and development will determine Italy's future economic well-being.

Since 1980 the rate of science and technology (S&T) spending in Italy doubled in real terms, and in 1987 Italy spent approximately $10.5 billion on S&T (about 1.5 percent of GNP). The Italian expenditure still lags behind the expenditures of other major OECD countries, as shown in Table 1. It is significant, though, that the number of researchers in Italy (a little over 62,000) is relatively small. This means that most Italian researchers are well funded with respect to their OECD counterparts.

Table 1. Science indicators in some OECD countries.

	USA	Japan	FRG	UK	France	Italy
Total R&D Expend ($ billion)	111	37	20	14	14	13.5
Expend as % GNP	2.8	2.8	2.3	3.9	2.3	1.45
Civil R&D % GNP	1.9	2.5	2.4	1.5	1.7	1.35
No. researchers (1984, thousands)	751	370	130	94	93	62
Expend per researcher ($1202)	149	89	153	153	143	161

NOTE: All data for Italy is 1987; other countries 1986, unless indicated.

Sources of Data:
CNR "State of Scientific research in Italy," Sep 1987
OECD economic indicators
ISTAT

Allocations in 1987 for public sector research are a good indication of Italian S&T priorities (Table 2). The largest recipients are programs in physics, biology and medicine, space, and engineering and technology which together comprise about 56 percent of the overall R&D budget. One area which diminished significantly is nuclear expenditures, which declined about 18 percent in 1987, reflecting strong antinuclear sentiment after the Chernobyl accident.

Italy's government promotes research in areas deemed important to economic competitiveness through support of "finalized projects" in certain critical technologies. The "third generation" of projects, approved last year, are shown in Table 3.

TABLE 2. Public sector research in key areas – 1987.

	Amount (billion lire)	Amount ($ million)	Percent
Mathematics	133.5	101	2.1
Physics	755.6	570	11.9
Chemistry	312.8	236	4.9
Biology and medicine	910.6	687	14.4
Geology and mining	134.4	101	2.1
Agriculture	463.8	350	7.3
Nuclear energy	443.2	334	7.0
Space	720.8	544	11.4
Engineering and Technology	1141.7	862	18.0
Interdisciplinary	538	406	8.5
Other	782.6	591	12.4
Total	6337.0	478	100.0

TABLE 3. New finalized projects, 1987-1992.

Projects	Amount ($ million)
Telecommunications	60
Robotics	52
Electro-Optical Technologies	41
Fine Chemicals	74
New Materials	65
Cryogenic Technologies	3
Enterprise "Internationalization"	8
Information Systems and Parallel Computers	49
Biotechnology	65
Building Technologies	89
Total	506

Following is an indication of some of the areas of excellence found in Italian industry and research laboratories:

- Robotics. About 40 Italian companies produce robotic equipment; among the most important are Ansaldo, Comau, DEA, FIAR, Prima Industrie, and the Selenia Elsag group.
- Artificial Intelligence. Olivetti has an artificial intelligence laboratory with locations at Ivrea and Cupertino.
- Lasers. ENEA is doing significant research on high-energy lasers. ENEA's Frascati Laboratory has developed a free-electron laser operating in the infrared band, and deriving power from a small, transportable accelerator called a "microton." ENEA also produces color-center and eximer lasers.
- Superconductors. Ansaldo of Genoa makes many of the European superconducting magnets used in high-energy physics machines. The company recently an-

nounced a program to develop a "high temperature" superconducting motor.

- Biotechnology. The Italian government last year approved a 400 billion lire (about $302 million) program over 5 years for advanced biotechnology. The projects include medicine and veterinarian research, chemicals, energy, environment, agriculture, and food.
- Telecommunications. CSELT of Turin produces satellite components and is developing low-cost optical fibers for data transmission. SGS produces large-scale integrated circuits using silicon and gallium arsenide. CNR's Institute for Special Materials for Electronics and Magnetism (MASPEC) in Parma is also working on advanced production techniques for gallium arsenide. Telettra (Fiat group) is applying electronics to telematics.

United Kingdo.n

James Devine, Science Counselor, US Embassy, London.

Much like the US, science responsibilities are decentralized within the UK government. Although there is a Secretary of State for Education and Science, his role in setting science and technology priorities is limited. An interministerial committee chaired by the Prime Minister meets periodically to decide on contentious science issues. Operationally, the government's principal science official is John Fairclough, Science Advisor to the Cabinet Office.

Funding for science is accomplished through the five Research Councils, through the Universities Grants Committee (which distributes monies to the universities) and through the other government departments. The amount spent by the Research Councils and the Universities Grants Committee constitutes the science base. In the current year, it amounted to £1.4 billion (about $2.3 billion [£1.00 = $1.70]). Civil science expenditures by the other government departments constitute £800 million ($1.3 billion) and Ministry of Defense expends £2.2 billion ($3.74 billion).

In the past several years there has been much criticism of the state of science in the UK. Critics note that the government's emphasis on "value for money" has adversely affected basic science. Another problem cited is the lack of money spent by industry on research and development. Critics also assert that salaries of scientists are low, which has resulted in the emigration of many of the better British scientists. Areas hardest hit by this emphasis on "value for money" have been the UK space program, astronomy, and high energy physics.

All agree that UK scientists are excellent at basic research. The difficulty comes in translating this capability into commercially viable products. To remedy this, the government has embarked on a series of institutional initiatives designed to improve British competitiveness. Most notably, the Advisory Committee on Science and Technology (ACOST) chaired by the Chairman of Rolls Royce, Sir Francis Tombs, has been established to advise the government on S&T priorities. To assist this committee, a Center for the Exploitation of Science and Technology (CEST) has been established at Manchester University. The government has provided some seed money, but the primary cost of operating it will be borne by industry. Thus far some 18 companies have subscribed to the center. Its primary purpose is to improve relations between industry and universities. The focus of the Center's efforts will be on identifying research that will pay off commercially in the 7- to 10-year frame.

The government is in the process of establishing a series of interdisciplinary research centers, most of which will be housed at various universities. The goal is to establish some 40 such centers over the next few years. Thus far, four have been set up: one on superconductivity at the University of Cambridge, one on molecular science at the University of Oxford, one on engineering design at the University of Glasgow, and one on surface sciences at the University of Liverpool. In addition, the Advisory Board for the Research Councils has recommended that universities be, in effect, segregated according to their research excellence. They would fall in three categories: *R*, *X*, or *T*. Those classified *R* would receive funding for research across a wide range of disciplines; those classified as *X* would receive finding for perhaps one or two research areas; and those classified *T* would be confined to teaching only. The recommendation has been criticized by many academic researchers.

The government is also pursuing so-called link programs, designed to enhance industry-university collaboration. Some £420 million ($714 million) are available over a 5-year period, with the government providing one half and industry one half. Specific fields include molecular electronics, advanced semiconducting materials, industrial measurements systems, and nanotechnology. In addition, the government has increased its contribution to

the ESPRIT program, a European Community program on advanced information technology.

The government has also changed its system of making research grants. No grants will be given if the particular research is close to market exploitation. Grants will be made to smaller companies or to cluster of companies, but not to individual large companies.

The US is keenly interested in the results of these various schemes, as they are designed to address many of the same issues that are also facing the US.

Federal Republic of Germany

Edward M. Malloy, Science Counselor, US Embassy, Bonn.

Among free world countries, the Federal Republic of Germany (FRG) ranks third in expenditures on research and development (R&D), behind the US and Japan, but about 40 percent ahead of either France or Great Britain. It is estimated that in 1988 the FRG will spend roughly $30 billion on R&D, over 90 percent of which is civilian or nondefense-related. Industry provides about 60 percent of R&D funding and accounts for about 70 percent of the performance.

Relative to gross national product, the FRG roughly spends roughly the same share, as does the US and Japan. However, the FRG spends substantially greater proportion of its gross national product on nondefense R&D (2.5 percent) than does the US (1.9 percent). Thus the FRG, like Japan, concentrates its R&D resources in areas that have direct economic payoff.

The single most important motivation shaping the FRG's collective R&D policy is industrial competitiveness. The world's largest trader, the FRG sells its products not on the basis of any price advantage, but rather on a reputation for quality and also servicing. Thus to maintain its competitive edge on world markets, German industry with support from the federal government invests heavily in R&D.

Relative size is a major inhibition. Roughly in proportion to population, Germany's R&D expenditures are one-half Japan's and one-quarter those of the US, consequently the FRG is a strong supporter of international, especially European, cooperation. While a somewhat less than enthusiastic participant in the EC's 5-year R&D program, the FRG plays a full and active role in EUREKA as well as focused programs like ESPRIT. At the same time, the FRG devotes considerable resources in seeking to expand cooperation with Japan and in maintaining the high degree of cooperation in R&D with the US. The major German high-tech firms have research facilities in the US; the federal government recently funded the start-up of a computer sciences center at Stanford University in California.

Another characteristic of German science and technology (S&T) that makes it unusual, if not unique, in Europe is decentralization. Historically, the various political units that were later to fuse into the nation of Germany had developed many centers of scientific excellence. Accentuating this historic decentralization of S&T was the federal system of governance chosen after World War Two. State governments are now a major source of R&D funding, particularly for universities but also for scientific institutes. State governments also provide strong support for local industries; for example, by developing technology parks, many states have highly developed S&T policies. The FRG appears to have avoided many of the problems associated with the rigid top-down administration of S&T policy and funding characteristic of other European nations.

Through much of the postwar period, German R&D was oriented to rebuilding Germany's industrial capabilities and to restoring its eminence in basic research. Now, however, matching its emergence as a major player in international relations, the FRG seems to be taking increasingly an across-the-board approach, paralleling the superpowers and matching France. In particular, postwar constraints of Germany's role in aerospace have disappeared and the FRG is embarked on an ambitious effort to develop advanced civil and military aircraft as well as space satellites, laboratories, manned vehicles, and launchers. While all of these activities are conducted in cooperation with other European countries, the end result in the next decades will be an autonomous capability.

The bedrock of German excellence in S&T is the nation's strong capabilities in basic research. Relative to other countries, Germany devotes an unusually highly proportion of its R&D expenditures, over 20 percent, to basic research. By performance, German universities and the more than 50 Max Planck institutes account for over 80 percent of the basic research activities, with industry performing most of the remaining.

As a result, basic researchers here enjoy strong and, what is perhaps more important, reliable funding. Backing up these researchers are perhaps the best laboratory craftsmen in the world as well as an adequate number of highly motivated students. Indicative of the FRG's suc-

cess in basic research is the fact that for the last 3 years German researchers have shared in the Nobel Prize for physics. The federally supported Max Planck institutes not only concentrate on specific areas of research but also offer researchers a chance to escape the "ivory tower" of universities, often retaining the cherished "Professor" title. They also appear to give researchers greater freedom to mix with colleagues from other countries and to cooperate with industry.

Spain

Ishmael Lara, Science Attaché, US Embassy, Madrid.

On March 21, Prime Minister Gonzalez presented the Spanish government's 4-year, 1988-91, National Science Plan (Plan Nacional de Investigacion Cientifica y Desarrollo Technologico). The US Embassy's Science Attaché attended the presentation as did representatives of other embassies. The presentation culminated 5 years of the Spanish government's effort in reorganizing the science and technology system. The plan is an effort to assure the effective coordination of research and development of nine ministries under the auspices of the interministerial commission on science technology. The plan augments the scientific and technological research development and coordination law of 1986.

In his speech, Prime Minister Gonzalez noted that Spain's R&D spending had doubled in the 1972 to 1987 period, going from 0.35 percent of gross domestic product (GDP) in 1972 to 0.72 percent of GDP in 1987. He mentioned that Spanish participation in European scientific projects had increased in the last few years, particularly in EUREKA, where Spain has 40 projects amounting to 30 billion pesetas (approximately $251.5 million). In 1980, he said, Spain was number 19 in the world in terms of scientific output and that in 1986 it was number 12 (1 being the highest). The national plan is composed of 23 national programs and various sectoral programs and is aimed at five areas: development of science researchers and the interconnection of informatic resources, agricultural production and natural resources, production technologies and communications, quality of life, and other special programs.

Prime Minister Gonzalez said that under the National Science Plan, the administration's budget is 55.14 billion pesetas ($462 million) for science and technology in 1988, and 662.48 billion pesetas ($5.553 billion) over the 4-year period.

It is difficult to determine from the Prime Minister's figures by how much the Spanish government is really increasing its spending on R&D and science and technology. As stated above, the national plan figures seem to include spending from all sectors.

Israel

Anthony Rock, Science Attaché, US Embassy, Tel Aviv.

Israel is a country which diversifies its scientific research and specializes its technology. Israeli researchers are recognized worldwide for contributions in areas such as medicine, agriculture, electronics, and energy. Technological developments for defense and civilian applications (e.g., aeronautics, chemicals, electro-optics, robotics, and materials) are generally competitive in the world market.

Israel invests 3.04 percent of its GNP (about $710 million) in R&D – high in percentage terms among industrial nations, but low in terms of actual dollars invested. The industrial sector performs 61 percent of the nation's R&D; 29 percent is performed in universities, and 9 percent in federal laboratories. The government supports 64 percent of all R&D performed (more than in Organization for Economic Cooperation and Development [OEDC] country); 55 percent of this support is to the military.

The Ministry of Science and Development (MOSD) was established in July 1982. Its major functions are to:

(1) promote basic and applied research and development in Israel with emphasis on areas of national importance; (2) coordinate the research and development activities of the other ministries; (3) foster scientific relations with other countries, in consultation with the Ministry of Foreign Affairs; and (4) encourage development of outlying areas of Israel's S&T capabilities.

An Office of the Chief Scientist is maintained in each of the other Ministries involved in technological affairs (e.g., Agriculture, Communications, Defense, Energy and Infrastructure, Health, and Industry and Trade).

This year, the Office of the Chief Scientist, Ministry of Industry and Trade (MOIT/OCS) will provide $85 million to assist Israeli industries to compete in technology-based export markets. OCS offers direct financial assistance for R&D, guidance and training for new enterprises, professional workforce development, cooperative links with foreign countries, and assistance in securing risk capital. OCS also provides financial support for centers of research excellence in Israel involving the joint research efforts of universities and local industries. Recently established centers address the areas of artificial intelligence, superconductivity, and biotechnology.

In Israel's civilian industry, there are about eight research scientists per 1000 manufacturing employees. Israel's R&D-based annual exports now total about $2.5 billion; however, of Israel's roughly 700 R&D firms, only about 4 percent produce 75 percent of exports. Israeli technology industry generally focuses on highly specialized markets. Principal R&D exports are in the areas of electronics (53 percent), aerospace (20 percent), and chemicals (10 percent).

Israel's Directorate of the Armament Research and Production Administration (MAFAT) in the Ministry of Defense is the principal administrative body which designs, directs, and controls military R&D in Israel. MAFAT's technological emphases include: electronics and computers, aeronautics, optronics, armament technology, materials and processes sciences, aerodynamic and hydrodynamic science, military chemistry, human engineering, military medicine, and product control.

The Armament Development Authority (Rafael [now a civilian organization]) – was established in 1950 as a special scientific unit of the Israel Defense Forces, devoted to improving existing armament and developing and producing new weapon systems. Rafael is divided into four main divisions – guidance control, aeromechanics, electronics, and engineering support. Its technologies include guided and unguided weaponry (including the specialized areas of detectors, propulsion, and warheads), electronic warfare, secure communications, electro-optics and thermal imaging, special computing systems, fuses, and pyrotechnics.

Israel's defense industries now reach international markets with products such as fighter aircraft, missile boats, inertial navigation and aircraft avionics, weapons delivery systems, electro-optics and thermal imaging, telecommunications, robotics, electronic warfare equipment, and biomedicine.

All seven major Israeli universities conduct scientific research, and each has developed a close link with local industry through a commercial arm or an associated industrial park. The Weizmann Institute of Science in Rehovot is internationally recognized for research and graduate training in natural sciences and mathematics. Many of the Institute's 300 scientists and 460 graduate students have made major contributions in cancer research, immunology, genetics, organic and physical chemistry, nuclear physics, and electronics. The Institute has established a company to promote its commercial opportunities and has provided support, since 1967, to a local science-based industrial park. Other Israeli universities are following this example.

Israel's center for applied research is the Israel Institute of Technology (Technion), with an academic staff of 1,100 and a student enrollment of 8,000. Technion's 20 academic divisions encompass the range of engineering from civil, mechanical, and electrical to aeronautical, nuclear, and biomedical.

Internationally recognized research in a range of scientific disciplines is also conducted at Tel Aviv University, Hebrew University of Jerusalem, Bar-Ilan University, and Ben Gurion University of the Negev.

There are currently 18 bilateral technical agreements between US federal agencies and their counterparts in Israel. In addition, the US and Israel maintain three science-oriented foundations – each endowed at roughly 100 million dollars – providing grants for joint projects in basic sciences, agriculture, and industrial R&D.

A Memorandum of Understanding for mutual cooperation in defense R&D and in scientist/engineer exchange was renewed in December 1987 for a period of 10 years. Finally, a Memorandum of Understanding between the US and Israel has been signed for cooperation in support of the Strategic Defense Initiative. The focus of Israel's efforts in this area will be in the development of theater defense architecture.

Egypt

Francis X. Cunningham, Science Counselor, US Embassy, Cairo.

The Egyptian science and technology establishment is not comparable to that of the US, Western Europe, Japan, or the Soviet Union. However, Egypt does good science, and probably ranks first in this respect among Arab countries, relatively high among developing countries, but behind those which have a strong commitment to S&T such as Brazil and India. Where Egyptian S&T is strong it tends to be in areas of social and economic concern such as agriculture and public health, rather than in advanced technologies such as superconductivity or artificial intelligence.

Egypt has 12 universities and an S&T community said to number 40,000 scientists and engineers. Although undergraduate S&T preparation can be weak, there are many opportunities for Egyptian students to do graduate work abroad (US, West Germany, Soviet Union, Japan), and Egyptians who do so and return as well-qualified scientists and engineers, ready to begin a productive career.

However morale is sometimes poor in Egypt's S&T institutes and university laboratories. Sophisticated equipment and instruments may be broken or unusable for lack of maintenance. Pay is relatively low. It is a great advantage if a scientist can become involved in a research project sponsored by the US or another country, because up to 150 percent of basic salary will be paid as a bonus, equipment will be maintained, and he will participate in a disciplined, focused effort. Otherwise, he will rapidly lose his currency, and in 5 or 6 years may be obsolete. This explains the S&T brain drain to Gulf State universities and elsewhere from Egypt, as well as the great appeal of US- and foreign-sponsored S&T projects to Egyptian scientists.

Most scientific R&D is done in the government's universities and technical institutes. The Academy for Scientific Research and Technology (ASRT) of the Ministry of Scientific Research is the central mechanism for coordinating preparation of the £57 million (~$24.6 million) 5-Year Plan for S&T which was intended to provide technical support for Egypt's 5-Year Plan for Social and Economic development. We understand that a review of performance and expenditures in the 1982-87 Plan is now underway in the ASRT.

University research receives some support through the university budget funded by the Ministry of Higher Education. The ASRT also funds specific projects in the universities. The ASRT has six regional R&D Centers in addition to eight scientific institutes. Several of the Ministries also support scientific institutes, and there are some nongovernmental S&T centers. Most of these institutions are well staffed; the senior staff is invariably trained abroad. Some of the institutes are well equipped, others are poorly equipped or not maintained.

Following is a summary of Egypt's primary R&D resources.

ASRT Institutes:

- Petroleum Research Institute. Does research on geophysical and geochemical exploration for oil and gas; petrochemical research; extraction of proteinaceous materials from algae. It also conducts targeted research for some oil companies under contract. (Director: Dr. Bahram Mahmoud, US-trained petrochemist.)
- Theodore Bilharz Institute. Prevention of schistosomiasis.
- National Institute of Standards. Like US National Bureau of Standards, conducts research on standards and materials and equipment.
- Helwan Institute of Astronomy and Geophysics. Monitors Lake Nasser and High Dam Basin; tectonics; astronomic research on meteors and planets. (Director: Dr. Rashad Qebesy, Japan-trained earthquake scientist.)
- Center for Metallurgical R&D. Ore dressing, extractive metallurgy, development of new alloys. Has pilot-plant manufacturing facility.
- Institute of Oceanography and Fisheries. Marine biology and related areas. Field stations in Hurghada (Red Sea) and Alexandria. A new campus has been built in Suez, but is not yet equipped. (Director: Dr. Mohamed Issawy.)
- Center for Remote Sensing. Started by US-Egypt cooperation, but now incorporated into ASRT. Site tentatively selected in a suburb south of Cairo to house the Center's laboratories. Mapping of natural resources, etc. in Egypt and some other Mid-East countries. (Acting Director: Engineer Ahmed Ayoub.)

Ministerial Scientific Institutes:

- National Research Center, of the Ministry of Scientific Research. Largest such institute in the Arab world. Staff of 3500 including 700 Ph.D., 38 laboratories, broad range of S&T specialties. Increasingly oriented to applied research linked to national development objectives, particularly health and industry. (Director: Dr. El Seesy.)
- Nuclear Materials Research Center, Ministry of Industry. Research on exploration and exploitation of radioactive ores.

- Desert Institute, Ministry of Industry. Research on the desert environment; hydrology (underground water); desert morphology.
- Geological Survey of Egypt, Ministry of Industry. Patterned after the US Geological Survey; field and laboratory research.
- The Ministry of Industry controls all public-sector industries, some of which have their own R&D centers such as the textile industry.
- Agricultural Research Center of the Ministry of Agriculture. Field stations throughout the country.
- Atomic Energy Establishment of the Ministry of Energy and Electricity. Tank-type (2-megawatt thermal) Soviet-supplied research reactor; research in nuclear physics, reactor engineering, waste management.
- Ministry of Health. Some research carried out in specialized centers and hospitals, primarily in public health and family planning.
- Institute of Irrigation, Ministry of Irrigation. Maintains ancient Nile records; distribution of water for agricultural use; research on sluicing and canalization, management of aquatic weeds. With US support has developed a Master Plan for the River Nile.

Nongovernmental:

- US Naval Medical Research Unit (NAMRU). R&D on infectious and tropical diseases. US and Egyptian staff; 40 years in existence and over 1,300 papers in medical science; library and facilities among best in region.
- American University in Cairo (AUC). Basic science and engineering; Desert Development Center.
- Some private sector industries have their own R&D centers; e.g., petroleum, plastic, drug industries.

Areas of Excellence:

- High Energy Particle Physics at Cairo University, Professor Omar Badawi (University of California at Berkeley and Soviet University). (Dr. El-Nady, Group Leader)
- Phytochemistry (extraction of chemical substances from plants) at National Research Center. (Professor Fayza Hamouda)
- Photovoltaics at Ain Shams University, School of Engineering. (Dr. Ibrahim Marzouk)
- Vector-Borne Diseases Center, Ain Shams Medical School.
- IBM Scientific Research Center. Computer modeling. Model of N. Sinai natural resources and minerals. Nonprofit, free.
- New crops from the Agricultural Research Center. Sugar beets; strawberries; soybeans; sunflowers. Commercial fish farms.
- Industrial technology. US petroleum industry has $1.3 billion investment and has trained thousands of Egyptians to the point where relatively few expatriates are now involved. this industry uses the most advanced equipment, technology, and management in Egyptian industry.

Turkey

Ronald K. Kirkpatrick, Science Officer, US Embassy, Ankara.

Turkey's science and technology policy is aimed at attaining the same technical and economic levels enjoyed by its peers – by which Turkey means the Organization for Economic Cooperation and Development (OECD). As a fellow member of both NATO and COCOM, Turkey sees no reason to settle for less. The Turkish government's general stance in pursuit of these goals is both activist and interventionist. In their minds, in principle and to the extent practicable, research and development, and science and technology should all be guided so that they serve the country's economic and defense development.

Detailed government guidance of research is not practical, however. The research and development community is relatively small compared to Turkey's population. Much of the research is done for heuristic purposes. Except in the area of agriculture, applied R&D is a relatively recent phenomenon in Turkey. Thus, while advancements in scientific research are valued and sincerely acknowledged by the Turkish science and technology, there is little government money available for research. In daily practice, then, the Turkish policies affect technology acquisition more than scientific research. Because Turkey is relatively weak in process and quality control technology, it imports much technology rather than attempting to duplicate its development. In this fashion, petrochemical, steel, and aluminum plants were built with Soviet technology; a refinery with Romanian technology; and various power plants with US, German, and Hungarian technology. Likewise, military production of F-16 aircraft and their engines, armored fighting vehicles, and a variety of other military equipment is carried out jointly with Turkey's NATO partners, again using imported technology.

This is not to say that Turkey makes no contribution to world science and technology. For example, Turkey is a strong participant in earthquake research and engineering. Turkey also has a foot in two scientific camps and plays an unusual dual role in science and technology. On the one hand, Turkey seeks certain technologies from the EC and OECD countries. Pollution standards and better means of energy conservation in industry are two examples. On the other hand, Turkey in turn provides both a technology proving ground for scientific and technological leadership in various fields for its Middle East and North African neighbors.

Turkey in recent months has held training seminars for Middle Eastern participants in food packaging, refrigeration, and transport, and also in cement production. Turkey also will hold a seminar on geothermal energy in the near future. In addition, the Turkish Standards Institute has the lead role in drafting common product standards for use by the 46 members of the Islamic Cooperation Organization (OIC). These standards will address the quality and safety of the region's products. They will also facilitate intraregional trade among the OIC members. Turkey thus functions very much as a source as well as a recipient of new processes and techniques.

BEHAVIORAL SCIENCES

Neapolitan Research on Psychological Adaptations to Pacemaker Implantation

by William Crano. Dr. Crano was the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He has completed his tour and has returned to Texas A&M University, where he is a Professor of Psychology.

Some Background

Although his youthful vigor and appearance belie the fact, one of the "grand old men" of European psychology is Giacomo Iacono of the University of Naples. His former students occupy almost all the major positions in psychology in the south of Italy, and he is generally viewed as a major force for progress in the developing enterprise of (southern) Italian psychology. Iacono studied under Fr. Augustino Gemelli, one of the founding fathers of Italian psychology. Indeed, it was Gemelli who, because of his widespread popularity and Church affiliation (he was a Francisian monk) resisted Mussolini's crackdown on the social sciences. (Gemelli later was to found the Catholic Universities of Milano and Rome.) Iacono explained to me that after assuming power, Mussolini decided that a flourishing social science was not in the best interests of a fascist state, and he took active steps to make sure that such a threat was minimized.

The outcome of Mussolini's actions is evident even today. Many of today's influential senior social scientists in Italy trained originally as physicians, since they could not study for research degrees in the social sciences. Medicine is not a bad preparatory training for advanced study in social science, but it must have been a daunting prospect to the budding Italian social scientist to undertake medical training merely to allow access to a field that might not ever become legitimized. Those in Italy who took this road were exceptionally dedicated, as well as being uncommonly smart, and this is apparent in the rate and quality of their research.

The outcome of Mussolini's edict was not only a reduction in the numbers of researchers in the social sciences during and immediately following World War II. Given the nature of the mentor relationship, the drastic restriction of numbers of qualified professionals also limited the number of new professionals who could be trained. As such, Italian social science is only now beginning to recover from the effects of Mussolini's policy.

After his studies with Fr. Gemelli, Iacono, having received his doctorate, worked and studied at Harvard for 3 years. He was involved in a major research project designed to study the effects of massive relocation of the working class residents of south Boston. Since he spoke both English and Italian, the mother tongue of many of the residents of this area, he was able to act as a participant observer in this research project, actually living in south Boston while he studied the reactions of those about to be relocated. This was an important training period for Iacono, as will be illustrated in my description of one of his recent research projects, which makes use of longitudinal observational methods to derive information about the phenomenon of interest.

After completing his work at Harvard, Iacono was faced with the choice of staying on in Cambridge, or returning to Italy. He chose to return, and settled in Naples. At that time the university had no psychology department. After some initial difficulties (despite his obvious qualifications, he was not a Southerner, so why should he be given a job?), he was awarded the position, and established the university's first psychology department (there are now two, owing more to political than scientific reasons).

In Naples, Iacono has been able to attract a very capable cadre of students and research associates. He directs a very active program, with a heavy emphasis on the study of psychological problems of an immediate, practical nature, as is characteristic of much Italian social research (see *ESN* 41-6:287-291 [1987]). Iacono's theoretical orientation has evolved over the years, from a sociological perspective best characterized in the book of Parsons and Bales (1950) to a more psychodynamically oriented vision today. In part, this is a result of his department's affiliation with the University of Naples School of Medicine and Surgery. Psychiatrists trained in this school are much more familiar with the psychoanalytic approach than, say, the more cognitive or behavioral orientations. However, though the theoretical filter has changed, the methodology employed to explore the theory still bears the mark of his early rigorous Harvard training.

A Representative Study

In the paragraphs that follow, I will present an example of one of Iacono's interesting research projects – a longitudinal observational study of the interaction of doctors and their patients, who have recently

received a pacemaker implant. In this project, Iacono and his associates followed 53 patients over a course of a year's interaction with their physicians in an outpatient clinic affiliated with the University of Naples School of Medicine. Typically, patients met with their doctors at 3-month intervals. The focus of the study was the patients' adaptation to the pacemaker, the factors that influenced this outcome, and the processes by which patients and physicians learned to cope with their dependence upon a machine to maintain their (or their patients') lives.

The research setting was the cardiac out-patient clinic of the University of Naples. Patients met with their doctors in the examination room of the clinic to discuss problems and to allow the doctor to monitor their hearts and the operation of the pacemaker. A trained observer from Iacono's research group was present at all doctor-patient interactions. Iacono has argued that such an observer forms a normal aspect of the cardiac clinic, where patients are accustomed to the presence of observers other than their physician. As such, the observer probably does not negatively impinge on the ecological validity of the data that are obtained in the investigation.

The observers were trained to be as unobtrusive as possible during the examination, taking notes of their impressions, but not entering actively into the physician-patient interaction. Patients' behaviors during two distinct periods were monitored: in the waiting room before the examination, and in the examination room itself.

In the Waiting Room. The observers noted that since the examinations were sequenced at fixed (3-month) intervals, the same group of patients would meet one another consistently over the course of the observational investigation. Iacono realized that this "preliminary" session was an important (if informal and unrecognized) feature of the standard examination, because in the waiting room patients would, among other things, exchange information on the workings of their pacemakers and compare the state of their health with that of the others in the room. Because the cast of characters was relatively consistent from one examination to the next, the patients formed fairly stable comparison groups, and used these groups to monitor their progress vis-a-vis that of their peers. Of course, considerable misinformation could be exchanged or assimilated during the pre-examination period as well, and all of this occurred independent of, and outside the knowledge of, the attending physicians.

In the examination room itself, the observers focused on the following behaviors:

- The physician-patient greeting
- Discussions of the patient's state of health
- Review of clinical tests (if any)
- Objective examination
- Checking the pacemaker's functioning
- Prescription and adjustment of drug therapy.

Consistent Contact. It is general practice in the University of Naples outpatient cardiac clinic for the same physician to maintain contact with a patient over the course of his or her treatment. This physician also attends, but does not directly participate in, the operation in which the patient's pacemaker is implanted. As such, he has a very complete knowledge of the patient, surgical complications, if any, and his or her family or social support system.

Iacono found that the consistency of the physician-patient relationship from visit to visit was very important to the patients. He speculated that the continuous link with the same doctor served as a source of stability for the patients which was reassuring and reinforcing. This was especially so because the physician was distanced from the traumatic events surrounding the implantation of the pacemaker. Even though the physician attended the implantation, he was not directly involved in the operation. As such, he was not associated with the trauma that surrounded the event.

So attached were the patients to their particular physician that they often were unwilling to submit to examination by another, when, for example, their own doctor was not available. Indeed, this relationship was so strong that patients often would refuse any medical treatment from other physicians until their own doctor had been consulted and authorized the intervention. This occurred even with problems that had nothing whatever to do with the pacemaker or the cardiovascular system. As Iacono observed, "One of the patients we observed was admitted to a city hospital with severe bronchial pneumonia, but refused all treatment proposed by staff physicians, deferring to the consent of the Unit cardiologists."

Further evidence for the importance to the patients of continuity in their relationship with the physician can be deduced from their attempts to establish and reinforce a close personal relationship with their physician. All of this evidence points to the importance, for the patients, of a personalized, consistent, and predictable relationship with the health-care provider. This should not be surprising in light of the fact that the patients felt that their well-being was in large part dependent upon the expertise and consideration of their physician. It is worthy of note that the consistency that characterized the doctor-patient relationship in the Naples cardiac outpatient clinic is quite contrary to that found in a common and increasingly popular medical setting in the US, the health-maintenance organization, or HMO.

Although the continuous physician-patient link was a source of considerable solace for the patients, it presents potential emotional costs for the physicians, since the pacemaker patients, on the whole, were old and frail. The life expectancy of this high risk group was not great, and the emotional adjustments that the physicians would have to make over the course of time as they lost their patients

despite their best efforts is a topic worthy of study in its own right.

Avoidance of Sensitive Issues. In the physical examination, the researchers discovered an interesting process of avoidance. Although it is clear that the patients were quite concerned about the possibility of a pacemaker breakdown (or the destruction of the pacemaker catheter), this issue was studiously avoided – by patient and physician alike. Instead, both patient and doctor focused on the functioning and duration of the batteries that powered the device. In some ways, this is understandable. The patients were strongly motivated to avoid the anxiety-inducing issues concerned with pacemaker breakdown – indeed, they minimized the potential problem by stating, when asked, that in the event of a pacemaker failure, their hearts could take over.

On the other side of the relationship, given the typical traumatic emergency circumstances surrounding the implantation of the device, the physicians also were understandably reluctant to increase patients' anxieties by discussing the real, if statistically remote, possibility of pacemaker malfunctioning. By focusing attention instead on a problem that was identifiable, controllable, and easily handled, both physician and patient sidestepped an area of potential emotional trauma. The cost of this avoidance, of course, was probably an increase in the general anxiety level of the patients, and a lack of clear understanding of appropriate actions in the event of an actual pacemaker failure.

Control. The pacemaker is strikingly different from other types of prostheses – e.g., hearing aids, artificial limbs, etc. – in a number of ways. Most importantly, the patient's life depends upon the pacemaker, while the other devices facilitate important, but not vital functions. Other prostheses are external, and can be observed and manipulated by the patient. This element of control is starkly absent in the case of the pacemaker, and thus, it is not surprising that the patient would seek for some ways of reestablishing "control" over a device on which his life depends. One means of establishing such control is through drug therapy. Although drugs themselves have nothing to do with the functioning of the pacemaker, they do have obvious implications for the patient's well-being and, perhaps even more importantly, they are under the direct control of physician and patient. As such, aspects of drug therapy took on enormous significance in the Naples clinical population.

In addition to reassuring the patient and providing him with the illusion of control, the power to prescribe drugs also held definite advantages for the physician. In the role of prescribing physician, the doctor shed the merely technical role of pacemaker mechanic, and assumed the more traditional role of health provider. No longer need the physician grapple with physical and mechanical problems with which he is ill trained to deal; in the realm of drug therapy, he can make use of his hard-won training and gain control over the therapeutic situation. Accordingly, we would expect to see great stress on drug therapy in such situations, and such indeed was found. This is not necessarily to suggest that compliance with the therapy was overwhelming. In their efforts to assume control, patients could either follow the therapeutic regimen assiduously, or ignore it. Either way, it is they who regain control of an organ that had been threatened and in some ways taken over by a mechanical device whose reliability is so important that it is never discussed.

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7/13/88

Effects of Relocation on Self-Concept and Adjustment

by Dr. Stefan Hormuth, with an introduction by William D. Crano. Dr. Hormuth is a professor of Psychology at the University of Heidleberg, West Germany. Dr. Crano, who was the Liaison Scientist for Psychology for the Office of Naval Research's Branch Office, London, has returned to Texas A&M where he is a Professor of Psychology.

Introduction

I first met Stefan Hormuth when he was a graduate student at the University of Texas. He was remarkably productive even then, and his postgraduate career has continued on this path. He has maintained his connections with his alma mater, even while working as a professor at the University of Heidelberg. On a recent visit to Germany, I met with Stefan and learned of a very interesting research project that

he has undertaken, which includes work that he recently completed for the German Foreign Office. Stefan has long been concerned with the self concept, arguably one of psychology's most central constructs. His work is characterized by the opportunistic use of naturally occurring events which have implications for the self. One such event is relocation. The German Foreign Office, for obvious reasons, was concerned with the effects of frequent relocations on the families of their employees. At their request, Dr. Hormuth conducted a long-term investigation on this issue, and has produced some very interesting results which, with the Foreign Office's approval, he has been permitted to share with us. The paper that follows describes some of the thinking behind Dr. Hormuth's research, along with some of his more important findings. What follows, then, is a short descriptive paper that Dr. Hormuth so graciously sent to me. It is published here with his permission.

Residential Mobility

Although residential mobility is of both practical and theoretical relevance, its effects have received very little research attention. From a psychological perspective, relocation represents a radical change in a person's relationship with his environment; such a change can have major implications for the self-concept. In my theoretical approach (cf. Hormuth, in press), the self-concept is considered to be part of an ecological system that consists of others, things, and environments. As such, relocation offers an interesting opportunity to study naturalistically the effects on the self of a major variation in at least one of these components. Relocation becomes, in effect, a quasi-experimental design that allows us to investigate the validity of our theories (in my case, of the self-concept) in a completely naturalistic setting. As such, results issuing from such research should be more readily generalizable to real-world phenomena than those obtained within the sterile, but sometimes somewhat artificial, research laboratory. More than merely being of theoretical importance, relocation in itself offers the opportunity for study of a phenomenon that is becoming increasingly important (and common) in today's highly mobile society.

As a research paradigm for studying self-concept, relocation is useful because it creates a radical alteration of a person's social and physical world. For some, these external changes are concomitant with other life changes that have to do with one's place in the social structure. For instance, relocation might occur in the context of a promotion, or it may result from a change in marital status, from single to married, or from married to divorced. Depending on the events surrounding the relocation, being in a new environment can lead to personal (self-concept) change through the person's passive adaptation to the new setting, through one's active resistance to change, or through a selective, active process where the individual chooses among the many opportunities a new environment affords. The macro (physical) environment, such as cities, lakes and streams, mountains, etc., can allow for, in some cases even foster, new experiences and behaviors. The micro environment – one's home, room, etc. – can be created by the individual in such a way as to support stability, or to foster change. As such, relocation is a naturalistic, quasi-experimental treatment that allows for the long-term study of active and passive processes of adaptation, stability, and change.

For most individuals, relocation is a relatively rare and significant life event. Within some populations (e.g., the diplomatic services and the armed forces), however, relocation can be quite frequent; as such, it offers an important research opportunity. It should be remembered that as a life event, relocation is itself neutral; however, it is frequently associated with other events that either reinforce or threaten a person's self-concept, and for this reason, is a useful method to use in the study of important processes in the development and change of the self-concept.

Research on Relocation and Self-Concept Change

In a program of research on the ecology of the self-concept involving more than eight studies (Hormuth, in press), I investigated relocation and its effects. This ecological research approach complemented my ecological theoretical approach. In addition to the naturalistic (quasi-experimental) treatment of relocation, I employed a multimethod measurement approach, which emphasized the ecological validity of the dependent variables administered. I used the "experience sampling method" (Hormuth, 1986) to obtain random samples of people's everyday behaviors and social experiences. At randomly defined intervals, subjects were asked to describe ongoing events in their lives, including thoughts, actions, etc. As these descriptive tasks were scheduled randomly, subjects did not know when they would occur. Subjects also took photographs of aspects of their environments that they thought were relevant to their self-concepts, and these pictures were analyzed in terms of their content and function. These complex longitudinal studies were preceded by cross-sectional questionnaires and survey studies (Hormuth, 1984).

A general overview of the results of my series of early investigations disclosed the following:

- In a new environment, people's behaviors occur at first in a greater variety of settings; the new environment is being explored.
- This expansion of environmental settings is accompanied by a contraction in social contacts.
- Over time, the relevant settings for action become established, and the variety of social partners decreases; however, the meaningfulness of these contacts increases.
- In effect, relocation involves an expansion of people's physical environment, along with an expansion of their (causal) social environment. With time, both of these environments contract, but at the same time may become more fulfilling.

These processes of exploration, change, and adaptation, were mediated by the self-concept. People with highly positive self-concept were more ready to deal with the new environment, and moved through the exploratory phase considerably more rapidly than those with less positive self-concept. However, even this latter group, after an initial rejection of the new environment, demonstrated the remarked-upon exploratory behavior, and appeared willing to gain and profit from new social experiences.

Relocation in the Foreign Office

Relocation is becoming a social and personal problem of increasing significance. Societal demands for relocation seem to be on the rise for professionals and, more generally, in times of economic restructuring. However, because it is a regular and relatively undramatic experience, investigators have paid little attention to this issue. This is a mistake, because for individuals and society, the costs of mobility can be high. Considering families, the most affected are those having divergent interests associated with a move, which puts strain on family relationships. For example, a father might be very pleased with the new responsibilities and remuneration his promotion and consequent relocation entails. His son, a high school junior, might be concerned with the close friends he must leave behind and the uncertainties of his new school and social life. The relocation means very different things to these two people. Continuous developmental processes may be interrupted as a consequence of relocation, not only for children and adolescents, but for adults as well.

An unusual opportunity to study the impact of frequent relocation on children and families was given when the Foreign Office of the Federal Republic of Germany became interested in this issue. We (Hormuth et al., 1988) conducted a worldwide survey among German foreign service families, including adolescents and adult offspring. Families from other departments of the German Federal Government whose jobs did not involve relocation served as a comparison group.

In general, no major differences between the highly mobile children and their less mobile peers were found. However, the mobile children were more affected when developmental or family problems occurred, owing to a less stable social support system and less differentiated institutional support. Problems resulting from moves were mainly a result of the accumulation of multiple stressors surrounding the move.

Adolescents' breaking away from their parental home is one of the most significant differences between the mobile and nonmobile populations. Instead of a slow process of gradually increasing distance from parents, offset by increasing peer support and interaction, the mobile adolescents' separation from the family is more sudden, often occurring at the time of the relocation. For lack of a stable group of friends, this transition period is more likely to be experienced alone, without peer support, and as such, is more likely to cause problems.

Some predictors of adaptation to a new environment can be identified. Preparation has to be complemented by an active exploration of the new environment. Presence of siblings and friends helps. Disagreements in the family about a new assignment preceding a move are related to longer and more difficult adaptation periods. Based on these and additional findings, a series of recommendations were developed for the Foreign Office. Some of these were addressed to parents, some to procedures within the bureaucracy, and some to the legal and structural conditions of the German Foreign Service itself. It remains to be seen if these recommendations will succeed, if adopted, but given the nature of their development it seems likely that they will result in more positive adaptation to the stress and strain that is concomitant with any major relocation.

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7/12/88

BIOLOGICAL SCIENCES

Imaging Cerebral Perfusion Defects Following Diving Casualties–A New Method

by G.H. Adkisson, M.D., R.R. Pearson, M.D., MFOM, and M. Macleod, M.D. Dr. Adkisson is the Medical Liaison Officer, Office of Naval Research Branch Office, London, and Institute of Naval Medicine, Alverstoke, England. Dr. Pearson, a Royal Navy Captain, is Head of the Undersea Medicine Division, Institute of Naval Medicine, at Alverstoke. Dr. Macleod, also a Surgeon Captain, is Head of the Nuclear Medicine Department, Royal Navy Hospital Huslar, Gosport, England.

The development at Huslar Royal Naval Hospital, Plymouth, UK, of a new imaging technique with Tc-99m labelled hexamethylpropyleneamine oxime (Tc-99m HMPAO) and single photon emission tomography (SPET) has allowed for *in vivo* imaging of cerebral perfusion defects secondary to diving accidents for the first time. This development is especially important now because recreational diving is increasing in popularity and greater numbers of diver are exposed each year to the dangers of dysbarism or pressure-related illness.

Dysbarism presents in two major forms, barotrauma and decompression sickness (DCS). Barotrauma involves tissue damage as a direct result of a change in volume of entrapped gas whereas DCS is a complex series of events initiated by formation of inert gas bubbles during or following decompression. The most significant form of barotrauma is "pulmonary overinflation syndrome" which often leads to cerebral arterial gas embolism (CAGE), a potentially lethal complication. Decompression sickness manifests in a wide variety of forms. Dysbarism, particularily DCS, while primarily a disorder of divers and compressed-air workers exposed to increased pressures, can also occur in aviators as a result of decompression to high altitudes.

There is growing concern that dysbarism can lead to long-term neurologic damage. Postmortem studies of the spinal cord have suggested that significant pathological changes in the central nervous systems (CNS) have occurred even when a good recovery appears to have taken place (Calder, 1983; Polmer et al., 1981). *In vivo* studies have demonstrated little of pathological significance despite the use of the most advanced imaging methods such as computerized tomography, radionuclide imaging, and nuclear magnetic resonance imaging, and despite well-defined clinical symptoms and signs of CNS involvement. Tc-99 HNPAO provides the first chance to view diving-related perfusion defects *in vivo.*

The search for an ideal agent to assess regional cerebral blood flow and thus allow for routine imaging of perfusion defects has been going on for some time. While some agents have existed, they have been difficult to use or expensive. As given in Ell et al. (1987) the characteristics of an ideal agent are:

- The molecule should be neutral and lipophilic to enable passive diffusion across the lipid bilayer.
- The extraction efficiency of the molecule must be high.
- Once trapped, the distribution of the molecule must remain effectively unchanged, at least over the timeframe of the imaging procedure.
- Clearance from brain tissue should be slow.
- The radioisotope used should be continuously available and have physical characteristics suitable for high-resolution gamma camera imaging.
- The molecule must be easy to use and safe.

Tc-99m HMPAO Scintigraphy

Hexamethylpropyleneamine oxime (HMPAO), marketed under the brand name Ceretec by Amersham International Plc in England, appears to meet the above demands. When combined with Tc-99m, an isotope used in 80 percent of all nuclear medicine procedures, HMPAO penetrates the blood brain barrier and becomes fixed in cerebral tissue with no significant redistribution (Volbert et al., 1984; Ell et al., 1985; Costa et al., 1986). Its half-life within the tissues is on the order of 40 hours, and imaging can be performed within minutes or can be delayed several hours following injection. Imaging gives a picture of cerebral perfusion pertaining at the time of injection rather than at the time of imaging. This has the distinct advantage that a diving casualty may be injected prior to recompression therapy and imaged hours later in the controlled environment of a nuclear medicine department. Single photon emission tomography (SPET) is performed using an orbiting gamma camera of the type found in most nuclear medicine departments. A sinogram is acquired using 360 forward rotation, 64 projections on a 64x64 matrix and 20-second acquistion time per projection. The reconstructed image contains 32 axial slices. Repeat studies can be performed at weekly intervals to monitor changes in perfusion patterns. Using this technique, the Nuclear Medicine Department at Royal Naval Hospital Haslar, Portsmouth, England, has imaged

several divers following dysbaric accidents, and perfusion defects, previously unseen in diving accidents, have been documented.

Case Studies

Case 1. A 33-year-old male was performing a free in-water ascent from a depth of 18 meters during submarine escape training. At the surface, he noted weakness with unusual sensation in his right leg and dyspraxia of the right arm. He was treated by recompression to 50 meters at the scene of the incident with resolution of his symptoms within minutes. He was decompressed over 5 hours and admitted to hospital immediately upon completion of therapy. At that time, detailed examination of the CNS was negative as were an EEG, ECG, and cerebral CT scan. CT scan of the thorax showed old apical scarring and several intrapulmonary bullae. The diagnosis was cerebral arterial gas embolism (CAGE).

The Tc-99m HMPAO SPET study obtained showed a hypoperfused area in two axial slices in the left fronto-parietal region.

Case 2. An 18-year-old male ascended from 28 meters during submarine escape training and was observed to hold his breath over the first 9-10 meters of the ascent. Upon surfacing he complained of tingling and weakness of his left arm. He was immediately recompressed to 50 meters with resolution of all symptoms within 15 minutes. Following decompression he was admitted to hospital where neurological examination was normal in all respects. The diagnosis was CAGE.

Transaxial and coronal slices obtained from the SPET study performed showed two areas of diminished perfusion, one in the right frontal lobe and the other involving the right parietal region.

Case 3. A 47-year-old female recreational diver undertook a series of dives up to 34 meters over a several-days period for which she had inadequate decompression. Following her final dive, she complained of stocking/glove paraesthesiae, nausea, vertigo, mild imbalance with slight weakness in her left leg, confusion, and slightly blurred vision. She was treated by recompression to 18 meters and experienced complete relief of all symptoms. She was treated on a USN treatment table 5 rather than on the required table 6 and, despite a recurrence of several syptoms during decompression, was surfaced and released from care with a refusal from the chamber to treat her further. Symptoms continued for several days during which time she arranged air ambulance transportation to the UK. During the flight home she experienced a worsening of symptoms and signs and the aircraft was forced to fly below 300 meters to alleviate these. She was retreated upon arrival in the Uk with resolution of her nausea and confusion but with little change in the paraesthesiae. Recompression treatment was discontinued when she developed signs of oxygen toxicity. She was admitted to hospital with complaints of paraesthesiae in a stocking/glove distribution. Neurological examination including EEG was normal. The diagnosis was neurological DCS with cerebral involvement.

Axial images obtained from the first study on Case 3 showed ischaemic areas in the left frontal, right frontal, and right parietal region. A second study, done 1 month later, showed continued ischaemia in all regions primarily affected with some extension of the ischaemic borders.

Case 4. This 23-year-old female sports diver did two dives to a depth of 20 meters for a total of 42 minutes. She felt unwell following the dives but attributed this to substantial alcohol intake and GI upset. She noted increasing lassitude, marked mental confusion, decreased vision, and paraesthesiae developing across both feet over the next day. Examination 36 hours postdive revealed a decreased sensation of the right foot along with generalized hyperreflexia and mental changes involving memory and concentration difficulties. She was treated on a Royal Naval table 62 with complete resolution of her symptoms. Forty-eight hours post-treatment she had a slight recurrence of symptoms and she was retreated on a modified Royal Naval table for 90 minutes at 18 meters. She again had complete resolution of symptoms without further recurrence. Follow-up examination was completely normal. The diagnosis was DCS with cerebral involvement.

Axial images revealed a large ischaemic lesion in the left fronto-parietal region with evidence of an infarct laterally. A follow-up scan 1 month later revealed minor resolution of the left fronto-parietal region ischemia but confirmed the presence of an infarct in the region.

Discussion

The ischaemic lesions demonstrated by HMPAO scanning in Cases 1 and 2 are compatible with the symptoms and signs produced in the right (Case 1) and left (Case 2) side of the body respectively. The location of the lesions in both cases supports a diagnosis of CAGE, almost certainly due to gas bubbles in the distribution of the left middle cerebral artery (Case 1) and the right middle cerebral artery (Case 2). Human experience suggests that the site most prone to emboli is within the distribution of the middle cerebral artery (Pearson, 1984) and these findings would support this.

The lesions seen in Case 3 are consistent with a more scattered distribution of bubbles. This is consistent with either multiple small inert gas emboli reaching the cerebral circulation or secondary disruption of flow due to autochthonous bubbles in the tissue. A combination of these events may also have occurred. Any gas bubbles within the system in this case would appear to be a result of inert gas loading. There is, at least, indisputable evidence of bilateral cerebral involvement.

The lesion demonstrated in Case 4 is quite different in character from those demonstrated in Case 3. It is a discrete lesion consistent with a blockage of the anterior branch of the middle cerebral artery on the right side. It is virtually identical to the lesions noted in Cases 1 and 2, both of which were due to CAGE. A discreet lesion of this type is more consistent with an embolic phenomenon than with autocthonour bubbles arising in the cerebral tissues. Despite this, nowever, the latency of onset, the lack of difficulty during ascent, and the type of symptoms would argue for the diagnosis of DCS rather than CAGE. It is possible that bubbles arising within the venous system in DCS may be later arterilized and cause a CAGE secondarily.

It is apparent from the repeat studies performed on Case 1 and Case 3 that prolonged cerebral ischaemia may result from diving accidents despite apparently good recovery. Evidence obtained in these four cases lends support to the current concern over potential long-term effects of diving and diving casualties. It will be of interest to ascertain how long the ischaemic phase lasts when further scintigraphy is performed at 3- to 4-month intervals, post incident, on each subject.

Tc-99m HMPAO imaging affords the opportunity of observing *in vivo* cerebral lesions for the first time following insult due to dysbaric-related accidents. It is a potential tool for studying diving casualties and gaining new insights into the pathology involved and optimal treatment protocols as well as for examining the long-term neurologic effects of diving injuries.

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7/21/88

COMPUTER SCIENCES

Artificial Intelligence in Santiago de Compostela

by Paul Roman. Dr. Roman was the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office from September 1984 to September 1988.

Where once thousands of pilgrims from all over Europe camped out during the festive season, there now stands a medium-sized, lively, and modern university campus. During my brief visit to the Universidad de Santiago I found the Artificial Intelligence Group (AIG) the most interesting entity within my areas of purview. It is headed by a vigorous, very active director, Professor J. Mira Mira, and it is embedded in the Computer Science Division of the Department of Electrical Engineering – which, in turn, operates within the very highly rated Faculty of Physics. Perhaps this somewhat unusual arrangement explains, in part, the strongly interdisciplinary nature of the research done in the AIG: physics, mathematics, computer architecture, software development – these and some others are all concerns of the group.

The AIG has about five permanent researchers. Apart from Mira, the best known other members of the group appear to be R. Ruiz and A.E. Delgado. There is also extensive cooperation with other, mainly but not exclusively, Spanish universities and even with some medical institutions. Much of the work is done with direct Spanish government support for "CAYCIT" projects, and also some of the European Community's ESPRIT project-moneys make their way to the AIG.

The current research of the AIG centers, essentially, on three areas:

- Basic research on fundamental questions of artificial intelligence (AI), knowledge-based systems, robotics, and cybernetics
- Mathematical models of neural systems, especially cerebral dynamics, sensory processes, cognition
- Applied work in expert systems and intelligent automation directed toward biomedical and clinical problems.

In this article I will consider only some selected work from the first area, i.e., basic studies on general questions.

Integration of Artificial Perception and Action

Mira defines a "generalized robotic system" as an artificial system capable of (1) sensing the environment, (2) perceiving and interpreting the sensory inputs in terms of appropriately general models of the environment and of the system itself, (3) computing appropriate strategies of action by planning and finding plausible action methods, and, finally, (4) firing sequences of motor and other effect or actions with the ability to dynamically control these actions. Surely, such a generalized robotic system is a dream of the future, but it is both necessary and possible to attack and solve right now certain aspects of the complex set of problems associated with an ideal, generalized robotic system.

One of the central issues along these lines is the nontrivial integration of sensing, perception, and action. Mira and coworkers recently made good progress in defining, analyzing, and partially actually building an advanced framework architecture for such an integration.

Conceptual Scheme of Integration. It has been commonly agreed for some time that the general (conceptual) structure for integration of perception and action may be well represented by the schematic shown in Figure 1. The scheme speaks for itself; but a few remarks should be added. The overall system allows for several modes of action; the selection of a particular mode is initiated by the external input from the external world (or an operator). The actual selection of a mode is performed by the command and control system, and it is based mostly on the present high-level sensorial information.

Information on the selected mode is sent not only to the planning component but also to the sensors so as to tune and optimize them as needed. Mode information is sent to a files system as well, which stores previous world representations and uses this knowledge, as well as the present world representation received from the planning component, to determine a new world representation. The latter is then sent back to the planning component.

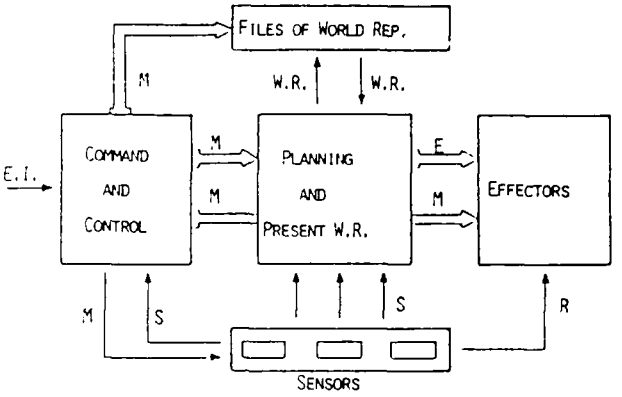

Figure 1. Scheme representing integration of perception and action. (E.I = external command input; M = information on the model; E = instructions to effectors; W.R.= world representation; S = sensory data; R = reflex path.)

Finally, the goals are established in accordance with the selected mode. The corresponding high-level instructions, together with direct transmittal of the selected mode, are then sent to the effectors, and are there decoded into concrete motor or effector actions. There is also a low-level sensory input directly to the effector component which initiates the "reflex" behavior observed in living organisms.

The Realizing Architecture. Mira and his coworkers devised a modern computer architecture, utilizing up-to-date AI concepts and techniques; this architecture embodies the system we just described. The architecture is shown in Figure 2. There are two types of specialized processors. The first (upper left) deals with the sensory data.

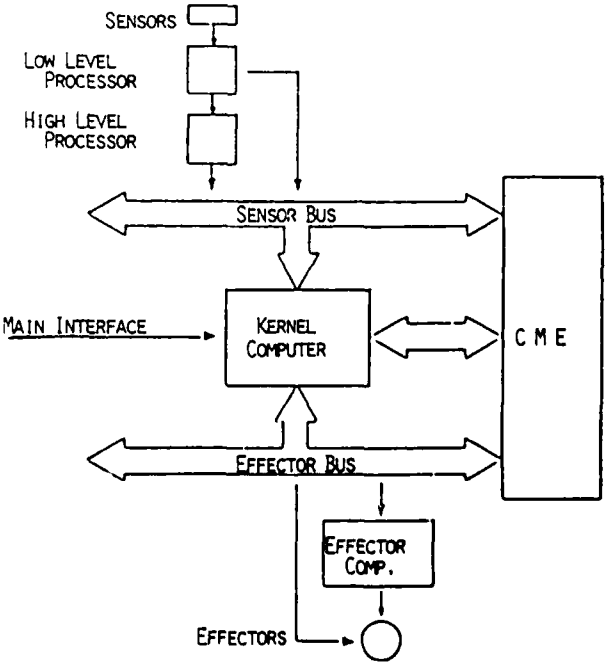

Figure 2. Computer architecture for integrated system. (CME = computer models of the environment.)

The second (the Effector Computer, lower right) is concerned with the effectors. These processors are connected to corresponding buses. The "serious" computations are done in two separate computers. Command, control, and planning is performed in the kernel computer (center of figure), while computations regarding models of the environment are performed in the unit labeled CME.

The Command and Control Part of the Kernel. First, consider that part of the kernel computer which is responsible for command and control. Its basic function is to commit the whole system to one overall mode of behavior. (The set of distinct overall modes is not very large.) This is precisely what enables the setup to behave as a well-integrated unit instead of a loose connection of separate sensors, effectors, and processors. Important to note is that such a computer unit receives relatively unprocessed information from all sensors situated both in the sensory and in the effector subsystems. Second, the kernel computer produces signals which control, tune, and set the filters of all external inputs. Finally, it also controls all information flow from and to the remaining higher level computers.

It is clear that a command computer of such nature must have a modular architecture. It will consist of a set of computing units, where each receives information only from a restricted part of the overall – and not much preprocessed – sensor inputs. But each unit is capable of doing both general diagnostics concerning overall input situations, and also of doing specialized diagnostics corresponding to the values received through the particular subset of input lines. Now, a consensus of the diagnostics – leading to the selection of a single mode of behavior – must be reached by the computing units in a rather short time. This can be achieved by arranging the units into a so-called cooperative processor (a concept coined earlier by Mira and colleagues.) The way to do this is to arrange for very strong crosstalk between the computing units. The ideas regarding the command and control computer part of the kernel (sketched in this paragraph) are summarized by Figure 3.

There are a few additional remarks to make about the cooperative modular structure of the command and control computer. In fact, the computing units can be regarded as simplified expert systems, working on their own data bases and with their own inference engines, utilizing their specialized domain of sensor inputs. However, modules which have a higher confidence about their diagnostics, can "recruit" the rest of the modules, making the latter "give up" before they concluded a diagnostic. Thus, via the strong crosstalk, the system converges rapidly into one mode. This arrangement not only lends speed to the architectural solution, but also assists reliability. Indeed, the conclusion that a consensus has been reached must not be the output of any specific testing unit receiving its inputs from the expert system modules. Instead, one must appropriately label the decided modes according to their precedents (so as to prevent mixing) and feed them into a noncomputing structure – i.e., some kind of decision bus (on the right of Figure 3). Clearly, this procedure is also facilitated by the modularity and division of expertise.

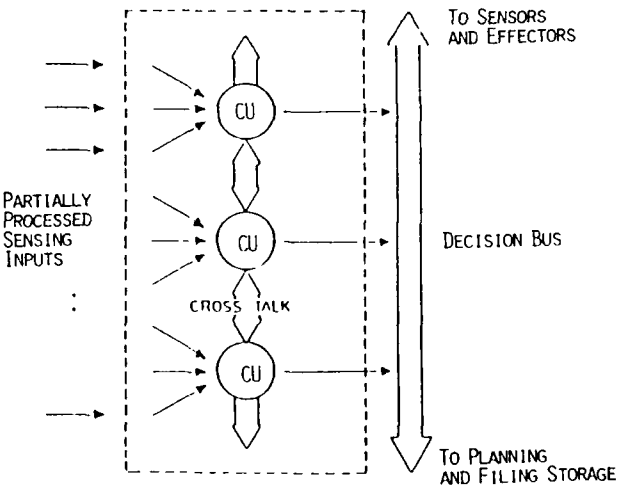

Figure 3. Structure of a command and control computer.

The Planning Part of the Kernel. The command and control subsystem of the kernel operates with expert units which receive very restricted data; on the other hand, the planning subsystem has general purpose units which may work on essentially raw data from different sources. Planning takes place in a world representation scenery (more about this later), which corresponds to the selected mode of behavior. Mira emphasizes that planning may be best performed by doing it at various levels of sensory data elaboration. Plan-generation AI methods for complex problem solving suggest several artificial problem domains, and these have been adapted for the planning procedures to be used in the Santiago integrated architecture. One interesting feature here is the distinct use of a low-level scenery (in addition to a high-level scenery), because the former permits the use of simple and efficient quasi-geometric methods.

Figure 4 illustrates how Mira arranged for a low-level planning. Of course, the blocks in the figure correspond to functions, not to hardware-structures.

Environment Representation. As mentioned earlier, the representation of the environment occurs in the "CME" computer shown in Figure 2, and is fed back to the planning part of the kernel computer, to be combined with the the mode decision and with sensory data. The AIG scientists spent considerable time on this CME function, but it would lead us too far to go into details. Suffice to say that, thinking in the framework of available and of planned highly parallel computers, Mira and associates

advocate the simultaneous use of two ways for structuring the multisensorial information into a world representation. These are: (1) integrated representation in one step, using all inputs (both at low levels of acquisition and at high levels of processing sensory data), and (2) step-by-step representation in simpler "channels" (where integration occurs later, at high levels, within symbolic or language structures). In the Santiago project, the command and control computer operates on data using step-by-step representation. The files of world representation and (at a later stage) the planning computer, make use of the integrated representation.

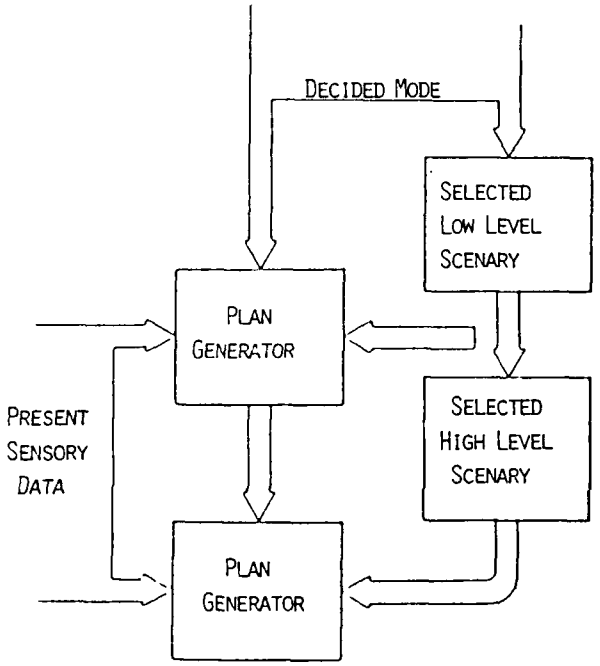

Figure 4. Two-level planning.

Summary and Future Work. The AIG impressively demonstrated that the integrated view of a system displaying nontrivial artificial behavior requires the inclusion of the general architectural components described above. (Actually, this may be only a minimal requirement.) The studied general structure is sufficiently concrete to be realized by available hardware. The AIG is now doing the experimental work, developing the details of the structure, of the functions of the components, and of the means of communication between parts. The first application is aimed at practical visual robotic systems.

Some Other Work and Concluding Remarks

Still within the area of general, basic studies, I was impressed by two, well-advanced projects.

The first (a bit related to the above-detailed work's future realization in practice) concerns intersensory communication in machines. The idea is that a practical computer frame for intersensorial communication is based on sensor-specific computations mapped into distinct representation spaces, which communicate to each other by what Mira and coworkers call "intersensorial transformations." The AIG group worked out the detailed mathematical theory of these mappings. Then they demonstrated that, using these transformations, computing facilities of one sensory modality may be shared with those of other modalities – provided certain conditions are fulfilled. Interestingly enough, the scientists convincingly showed that this "paradigm" (I wish this word were prohibited by law!) may be relevant for explaining some intriguing and peculiar properties of the human cortex.

The second project I mention dealt with the theory and technique of reconfiguration in "lesion-tolerant" multi-microprocessor systems. A careful approximative solution of the reconfiguration problem in a specific (but sufficiently broad-structured) system was obtained, ensuring that the goal of long-time reliable operation and low cost of realization be optimized. Criteria governing the system reorganization after a module failure, and a program for the reassignment of the application tasks in such an event, were developed.

Clearly, the above three topics were but randomly selected examples from only one area of the AIG's research program. But I was impressed by both the depth and the breadth of the program, and once again marveled at the unusually high proportion of good AI researchers on the Iberian Peninsula.

7/20/88

CONTROL SYSTEMS

The French National Research Institute in Informatics and Control

by Daniel J. Collins. Dr. Collins was the Liaison Scientist for Aeronautics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He has returned to the Naval Postgraduate School where he is a Professor of Aeronautical Engineering.

The French National Research Institute in Informatics and Control (INRIA) has four primary centers in France. I visited the center at Sophia-Antipolis, directed by Dr. P. Bernhard, who obtained his Ph.D. from Stanford. The center was opened in 1983 and now has a permanent staff of 90, of whom 45 are research staff. In addition to the permanent staff there are another 90 people working at INRIA on contracts and as doctoral students. Bernhard said that the center puts equal weight on fundamental research and on applied research or applications. He further felt that scientific recognition and contracts in applied work were both necessary for the successful running of the center. Technological transfer and industrial relations are therefore emphasized. As part of this transfer it should be mentioned that since 1980 10 research companies have been founded as a result of scientific innovations at INRIA.

INRIA summarizes all its projects under eight program headings. Although the Sophia-Antipolis center does not have projects under all the program headings, it is worth listing these divisions as they give a good idea of the research direction of INRIA and the relevant program headings further serve as an outline for the rest of this article. The program headings (responsible person in parentheses) are:

- Programmation (G. Kahn), Symbolic Calculus (G. Berry), and Artificial Intelligence (P. Neveu)
- Computer Architecture [not at Sophia-Antipolis]
- Networks and Distributed Systems (P. Nain)
- Data Bases [not at Sophia-Antipolis]
- Control, Production, Treatment of Signals and Data (P. Bernhard)
- Robotics, Image and Vision (M. Berthod)
- Scientific calculation, numerical codes, computer-assisted engineering (A. Dervieux)
- Man-Machine Communication (A. Michaud and M. Mlouka)

Although there is not presently any local activity, as indicated, under the heading of computer architecture, Bernhard stated that work will begin shortly in this area. The Sophia-Antipolis center has some 56 research projects which are categorized under six of the above headings. I will now consider the research being conducted under each heading.

Programmation, Symbolic Calculus, and Artificial Intelligence

In the programmation area Dr. G. Kahn and his colleagues are interested in the development of new editors, interpreters, and compilers which facilitate correct programing. An interactive program called CENTAUR has been created which is used to test new ideas and ergonomic factors. The new ideas include, for example, semantics of languages, strong typing, and tree manipulation which are designed to facilitate complex error-free programing. Ergonomic factors include high-resolution screens, window environment, use of menus, etc. This is a joint project with the Netherlands under an ESPRIT program.

In the symbolic calculus area Dr. G. Berry is concerned with parallelism, synchronization and real-time programing. This is a joint project with the Ecole des Mines, and I have already reported on the use of the codes MEIJE and ECRINS. I would add at this point that ECRIN is written in LE-LISP, a dialect of LISP. The main purpose of ECRIN is to insure the validation of paral-lel programs. The real-time aspects and the synchronization effect are studied through the language ESTEREL.

In the area of Artificial Intelligence, Dr. P. Heveu and his colleagues are developing a multiexpert system, SMECI, which is to be used as part of the simulation of a complex system such as a submarine in an operational environment. In the multiexpert system one of the problems is the resolution of conflicts between several knowledge bases. A supervisor is being constructed to do this resolution. The idea of a multiexpert system coupled with an operational simulation is a new idea which may lead to some new concepts. SMECI is written in LE-LISP with interfaces to LISP, Fortran, and C and is an object-oriented language. The code has been released since January 1988 and is said to be available in French and English. All the descriptive material that I have is, however, in French. Scientific contacts on this project include

people at Massachusetts Institute of Technology, Cambridge, and Carnegie-Mellon University, Pittsburgh, Pennsylvania.

Networks and Distributed Systems

In this area the performance of information systems is evaluated and new networks and models developed. The Center's present emphasis is on high-bandwidth (60 kHz/sec) information distribution systems; this work is in cooperation with the University of Maryland. Projects in networks and distributed systems naturally involve distributed processor systems and hierarchical systems. Thus, further work is concentrated on information systems that have a high degree of parallelism since these systems require new modeling concepts. Simulation and modeling with the required validation concepts are a large part of the activity. Work is also in process on modeling of parallel numerical integration systems, and in the modeling of distributed data base systems.

Control, Production, and Treatment of Signals and Data

One of the main technical thrusts in this area is estimation and identification of stochastic dynamical systems which may involve nonlinearities. Failure detection is one aspect of the identification problem and thus there is an emphasis on the development of real-time rapid algorithms for both estimation and control. One of the current projects (in cooperation with l'Aerospatiale Marignane) is concerned with the determination of the flutter speed of helicopter blades as influenced by the turbulence level of the wind. An algorithm was developed to simulate the stochastic process and real-time observation was used in order to predict the appearance of flutter in the course of actual flight. Another project, this time with the Renault company, is concerned with the use of a semiactive suspension system to improve the ride quality of an automobile. Optimization criteria include that of improvement of road-keeping ability and minimization of wheel slapping. The mathematical modeling is both stochastic (due to changing road conditions) and nonlinear.

Another project in this area is the application, with emphasis on modeling, of differential gaming to the analysis of complex biological systems. As part of the work in this area there is also some analysis of approximation methods based on the L2 norm. This work is perhaps complementary to that of the University of Oxford's K. Glover on Hankel norm approximations.

Robotics, Image and Vision

Essentially, the work in this area is the treatment of images both from a technical viewpoint of robotics and from a general image processing viewpoint, as with terrain photographs in geological applications. I would like to emphasize one project which I found very interesting since it combined image processing with an expert system: an astromonical plate can contain thousands of pieces of information which ordinarily would require considerable time-consuming analysis on the part of the astronomer. M. Thonnat has developed an expert image processing system that saves all this analytical work by generating an automatic morphological description and classification of galaxies. The system contains some 37 prototypes and 106 rules. This work has been done in cooperation with G. De Vaulcouleurs at the University of Texas at Austin. The methodology developed in this project is being extended to other complex visual systems with a current application in marine biology involving the automatic identification of zooplankton.

A large part of the effort of the group is devoted to the development of improved imaging techniques for terrain photographs from the French SPOT satellite. This latter work is concerned with the difficult problem of three-dimensional image processing from stereographic photographic images. Finally, there is a project (headed by J. Boissonnat) which is devoted to vision problems as they specifically relate to robots – consideration is being given to cooperative activity between robots and robots operating in parallel.

Scientific Calculation, Numerical codes, Computer Assisted Engineering

Emphasis in this area is on numerical simulation of both aerodynamic flows and of flows with combustion. Due to the Hermes program there is considerable current emphasis on hypersonic flows. A recent report of the research was released concerning investigation of the development of a strong shock in a reentry flow ranging from Mach number 15 to 25. A finite volume discretization of the governing equations (both Euler and Navier-Stokes) was used in the flow solver. Chemistry was handled by equilibrium algebraic equation with five species included. The purpose of the research was to capture the strong shock with a robust solver and with mesh adaptation. In a cooperative effort with chemistry people at the University of Marseille this work is to be extended to nonequilibrium chemical reaction with 18 equations. There is, of course, a tradeoff between the complexity of the chemical formulation and the speed of the solution. Much of the current work in hypersonics repeats work done 25 years ago but with newer algorithms and methods.

The Center's other work in this area is concerned with external flows around airplanes at subsonic, transonic, and supersonic speeds. There is also some analysis of internal flows of internal combustion engines and rocket chambers. As is common in this type of research

there is quite a bit of effort devoted to adaptive grids, and graphic presentation of the numerical results appears to be a strong point of the group.

Man-Machine Communication

One of the projects of the Man-Machine Communication Group is electronic publication and text treatment by office machines. Not too surprisingly this is funded by the French office machine company Bull-Transac. Emphasis is on the development of a dialogue interface in the applications environment with the generation of particular facility for graphic presentations. A second project in this area deals with multialphabetic text preparation including Arabic, Greek, Russian, Sanskrit, and Hebrew among others. The group has developed a multilingual code which permits generation of interfaces in almost any language based on an alphabet.

Conclusion

INRIA's Sophia-Antipolis center is truly an impressive research institution with much interesting work being conducted, in particular, in the application of artificial intelligence methods to a variety of disciplines. These include pattern recognition methods, multiexpert systems, and man-machine interfaces. The center has a strong effort in the modeling and analysis of complex systems from a theoretical and system point of view. Although there does not appear at present to be a strong interaction with the university environment – with a resulting flow of doctoral students such as at CERT in Toulouse – I understand that an effort is being made in this regard. There does, though, appear to be strong and healthy interaction with industry and with American research institutions.

I have only covered a few of what I consider to be some of the more interesting of the 56 projects at INRIA Sophia-Antipolis. I believe that Dr. Bernhard has created a young and dynamic research institution at Sophia-Antipolis which should continue to be an important center for informatics and control research in France.

07/26/88

Controls Research at the University of York

by Daniel J. Collins.

The University of York, which was founded in 1963, is one of the newest universities in England. The university is fairly small with a student body of 2800 undergraduates and 900 graduates organized into colleges as at Oxford and Cambridge. Controls research is conducted in the Electronics Department, which was started in 1979 and is directed by Professor G. G. Bloodworth. The department is in the process of expanding and is seeking to add four new staff members to the present staff of 18. There are about 70 students in the electronics curriculum. My review will emphasize the controls research but there are some other interesting activities in the electronics department which I will also comment on.

Controls Research

Dr. R. J. Patton with about six doctoral students is responsible for controls research in the department. An interesting feature of the control research is its emphasis on flight controls. Patton indicated that his control group is one of the few in England to have a flight control emphasis. All research is done on contract either for the UK's Science and Engineering Research Council (SERC) or Ministry of Defense (MOD). With some overlap, the four research themes of the group are eigenvector assignment methods, robustness, sliding mode controllers, and frequency identification methods.

Eigenvector methods underlie some recent work both on fault detection and the development of robust controllers. Patton has developed a robust fault diagnosis for model-based systems using eigenstructure assignment (Patton 1988). An advantage of the approach is that the original coordinate system is retained in the analysis. The eigenstructure assignment creates a decoupled structure in which the observer's response is in a manifold which is invariant to disturbances and parameter variations. The method is illustrated by a multivariable nonlinear aircraft system. Fault detection methods have previously been applied to the Harrier and are now being applied to jet engines diagnostics in a current contract.

In a series of recent papers Patton, with one of his doctoral students (S. K. Mudge), has made a thorough examination of robust eigenstructure assignment. In an application to aircraft lateral motion with a stability augmentation system, they have defined allowable eigenvector subspaces and have developed, although iterative-

ly, techniques for decoupling and for perturbation insensitivity (Mudge et. al., 1988). The singular value decomposition method is applicable to both real and complex eigenvalues.

Patton has also applied sliding mode controller work to aircraft vehicles – in this case to a remotely piloted vehicle (RPV). The main aspect he investigated has been the ability of the sliding mode controller to handle uncertain parameter variations. Essentially then this is another analysis of the robustness of the system with the controller, again using eigenstructure assignment as the fundamental approach. The results of the analysis is that nonlinear and perturbed systems can be forced to exhibit the behaviour described by the null-space dynamics.

The frequency identification methods involve perhaps more standard approaches such as least squares curve fitting. Interestingly enough the problem being addressed is that of helicopter identification so there can be considerable technical difficulties due to nonlinearities and cross coupling.

Other Research

Dr. N. Allinson has two interesting projects. The first involves imaging, but with emphasis on x-ray imaging. Many of the concepts of standard imaging processes carry over into this domain but the sensors are custom designed, charged-coupled, and amorphous silicon devices. Allinson has developed some unique sensors with short integration times. The second project is concerned with computer vision problems with particular applications of neural networks to pattern recognition and early image processing. Allinson demonstrated a very effective neural pattern recognition system for me.

Dr. R. W. Taylor , newly added to the faculty, is concerned with parallel computing hardware and distributed systems, and parallel algorithms. Taylor is interested in developing a 450-node transputer system. He is presently simulating the nodes on a Sun with the tree structure on the main frame of a VAX cluster 8650. He is presently developing parallel algorithms for industry and hopes to use the facilities that he develops in calculations involving large eddy simulation.

Conclusions

Some of the best research in eigenstructure methods that I have encountered in Europe is being done by Patton's group at the University of York. It is also interesting to see these methods being applied to aircraft problems, which in one sense is the natural applications area. York University is small but there is interesting work going on there and there appears to be a very good industrial interaction.

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8/1/88

FLUID MECHANICS

Experimental and Numerical Fluid Mechancis at Erlangen

by Daniel J. Collins.

The Lehrstuhl für Stromungsmechanik (LSTM) at West Germany's University of Erlangen-Nurnberg is directed by Professor Franz Durst, an international expert in development and application of laser Doppler anemometry (LDA) techniques to fluid flow measurements. Of the total staff of 60 at LSTM about half are scientific staff many of whom are working on their doctorates. There are an additional 10 guest researchers from different countries and around 25 undergraduate students working on their diploma arbeit. The teaching activity of LSTM is within the chemical engineering program and some of the research interest reflects this orientation. Applied research funded by industry represents about 40 percent of the institute's activities while the remaining basic research is funded by such organizations as Deutsche Forschungsgemeinschaft (DFG), Stiftung Volkswagenwerk, and Bundes und Landesministerien.

LSTM is divided into six research groups the titles of which give a good idea of the main research directions of the institute. The six groups are (with their directors):

- Fluid Flow Measuring Systems (Professor Dr. F. Durst)
- Experimental Fluid Mechanics (Dr. Ing C. Tropea)
- Computational Fluid Mechanics (Dr. Ing M. Peric)
- Two-Phase Flows (Dr. Ing M. Sommerfeld)
- Rheology (Professor P. O. Brunn)
- Flows with Chemical Reactions (Dr. Ing M. Sommerfeld).

This review considers each group and highlights selected projects. There is close interaction between the experimental fluid mechanics group and the computational fluid mechanics group since the experimental work is supported by theoretical calculations in almost all cases.

Fluid Flow Measuring Systems

Many innovative methods in LDA have been developed by Durst since he first began working in the area a number of years ago with J.H. Whitelaw of Imperial College. Durst's recent work has been on fiber optic systems, miniaturized systems based on semiconductor lasers, and special flow field visualization methods. A fairly advanced project with some work being done at the Franco-German Institute at St. Louis (ONRL Report 7-017-R [1987]) is that connected with the measurement of wind velocities. The present wind LDA system with receiving and transmission optics, formed from a 17-inch Celestron telescope, can measure velocities at a measurement distance of 150 meters. The present system is fully portable with its own power generation equipment and is contained in two large moving vans. Signal processing is based on photon correlation methods with an extensive software support program for diagnostics and calibration. Future developments with specially designed optics of about double the diameter aim at a measurement distance of 1500 meters. Other large measurement distance (long-throw) LDA systems involving similar technical problems have been developed for measurement of air flows around full-scale automobiles with the purpose of determining the optimal aerodynamic design. Volkswagen is to install such a long-throw system at its research laboratory.

Durst indicated that his interest is confined to LDA techniques and methods not presently available. In this respect two small companies have been recently established by students of Durst to commercialize devices developed at the institute. The new devices and optics are almost immediately adapted to experiments by the other groups. Rather than discussing those devices here I will cover them in the project descriptions given below of the other research groups. Some idea of the diversity of the equipment may be obtained, however, from the knowledge that some 14 different and special-purpose LDA optical systems are in use in the institute.

Experimental Fluid Mechanics

Special emphasis is given to laminar and turbulent flows with separation or recirculation zones. As part of his doctoral work G. Dimaczek has been conducting an extensive series of measurements in the recirculation zone behind a backward-facing step in a water tunnel at Reynolds number up to 8000. A specially designed computer controlled LDA system based again on photon correlation with an automatic traversing system is used in the experiment. Experimental results were reported in the Lisbon LDA conference in July 1988. This project is basic in nature and is distinguished by the high Reynolds number and the extensive and detailed measurements. Financing is from DFG.

The fiber optics system with a special laser sensor (mentioned above) has been applied to the determination of the velocity fields in turbomachninery and in particular internal combustion engines. For next year emphasis will be both on motored and fired engines. Part of this program is in cooperation with J. Whitelaw at the UK's Imperial College. In this project an effort will be made to use semiconductor lasers as the coherent source , a rather innovative approach, in the LDA systems.

Computational Fluid Mechanics

Dr. R. Kessler indicated that the main effort in the area of computational fluid mechanics was concerned with multigrid methods. Some of this work is in cooperation with Professor J. H. Ferziger of Stanford University, California. Multigrid calculations using finite volume method for the two-dimensional Navier-Stokes have been made for the backward-facing step at high Reynolds number (see above). By using solutions on grids of different sizes, an error estimate is made of the solution as a function of position in the velocity field. This permits determination of the grid size needed for a given error tolerance. Calculations have been made not with the normal staggered grid but with a colocated grid. The advantage of colocated grids is clearly evident in grid refinement methods and nonorthogonal grids, but colocation has been avoided in the past. Detailed comparisons of the two grid methods for a variety of flows made by Peric indicate also more rapid convergence for colocated grids in some flows.

Although the group's fluid mechanics calculations are presently being done on series machines, there is some interest in parallel calculations. This interest is motivated by the existence of a distributed reconfigurable multiprocessor system, DIRMU, directed by Professor

W. Handler of the Computer Science Department. DIRMU is essentially a testbed for high-performance multiprocessor configurations. The computational system consisting of 26 processors, can be programed into networks such as an array, cube, ring, pyramid, tree, etc. Some recent work has been on fault-tolerant multiprocessor systems. Durst feels that DIRMU is an excellent tool for testing parallel computer methods. In my visit to DIRMU I was impressed by the software support developed for the multiprocessor laboratory. A contemplated extension of the system to about 500 modern processors (presently the system uses the 8086 chip) could result in some exciting fluid mechanics calculations.

Two-Phase Flows

Dr M. Sommerfeld indicated that his group places special emphasis on gas-particle jet-flows, liquid-particle fluidized beds, and bubble flows in surface-aerated tanks. An intriguing industrial investigation is concerned with the laser determination of the size of bubbles in Champagne. It appears that the smaller the bubble size the higher is the perceived quality of the champagne. Perhaps relatively minor variation in the manufacturing process could change the size of the bubbles and therefore the perceived quality. In the future, on-line laser anemometry may determine the quality of champagne (with the consequent elimination of the expert taster). One can also envision advertisements on "the champagne with the smallest bubbles" – good champagne, perhaps, but a flat prospect.

In a more fundamental investigation, Sommerfeld has numerically simulated particulated expansions in supersonic free jets. The analysis is based on the Lagrangian statistical discrete particle method combined with the piecewise linear method which includes good shock structure and discontinuity capture. A model including elastic particle-to-particle collisions has also been developed. An interesting series of graphs shows the effect of particle size. Some experimental measurements are now being conducted on particulated jets expanding into a vacuum. Further experimental work in two-dimensional jets shows good agreement between theory and experiment.

Other experimental work involves the influence of the wall on particle flows with the practical application of trying to reduce wall corrosion in two-phase flows. An extensive experimental facility is directed at the aeration of water. Aeration in water purification involves some interesting technical problems coupling fluid mechanics with biological activity. It turns out that optimal aeration techniques also have the beneficial result of a significant saving (indeed on the national level) in the pump energy used. Finally, a special mass flow sensor for two-phase flows based on LDA is being tested. This latter system can be applied to non-Newtonian fluids, corrosive fluids, and medical applications where high accuracy is needed.

Rheology

Flows with non-Newtonian fluid can be rather complicated, often with what are at first unexpected results. Several fine experiments in well-defined flow situations such as sudden expansions and contraction have been conducted and analyzed by the group. Rather than discuss this material I would like to highlight the newly developed direct velocity gradient measurement system developed by LSTM. Newtonian fluids have a viscosity that is independent of the velocity field. With non-Newtonian fluids the viscosity can be a function of the velocity gradients. Thus a direct measurement of the velocity gradient yields important information as to the spacial distribution of the viscosity of the fluid. The spacial variation of the viscosity will also be time dependent in unstationary flows. The measurement system is based on a dual-point LDA system with point separation of about 0.1 mm. With the determination of the velocity gradient, direct measurement of local shear and elongation rates becomes possible. Future application of this measurement system should materially increase knowledge in rheological flows.

Flows with Chemical Reactions

The group's work in this area is just starting. Their first experiment involves LDA measurements of suspended stabilized flame between two opposing nozzles (*ESNIB* 88-05:34-36 [1988]). The flame is nicely stabilized through special digitally controled flow valves. An interesting part of this project is that similar work will be done in Paris on the same type of equipment, and, indeed, cooperative activity is planned with the Paris group. I found this cooperation interesting because although I have often found collaboration by groups such as this with American institutes I have rather rarely found European interactions outside of EEC efforts.

Conclusions

Clearly, world class work in fluid mechanics and especially laser Doppler anemometry is being conducted at LSTM. Professor F. Durst has been and continues to be very innovative in the development of new laser measurement techniques. LSTM is one of the best experimental laboratories in fluid mechanics that I have visited in Europe.

8/1/88

MATHEMATICS

Applied and Theoretical Mathematics at the Weizmann Institute

by Daniel J. Collins.

Introduction

Israel's Weizmann Institute of Science is located on a pleasant 250-acre campus in Rehovot, 14 miles from Tel Aviv. The total staff, numbering, about 1800, includes some 500 students at the Feinberg Graduate School who are pursuing M. Sc. and Ph.D. degrees. There are in addition, over 100 visiting scientists or faculty. The institute has 21 research units, grouped into five faculties – mathematical sciences, physics, chemistry, biophysics-biochemistry, and biology. My visit to the Mathematics Department was motivated by the active program in control theory directed by Professor I. Horowitz.

The mathematics research activities are divided into two areas of concern, applied mathematics (nine professors and 32 research students) and theoretical mathematics (six professors and 11 research students). In theoretical mathematics I investigated control and optimization, mathematical economics, and operator or estimation theory. In applied mathematics I was able to review the work in feedback systems, robotics and vision, fluid mechanics, and theoretical biology. Naturally enough, there are other activities that I did not get a chance to cover. For those interested, the Weizmann Institute publishes a yearly research review, available from the institute, which gives information on all research activities.

Theoretical Mathematics

Mathematical Economics. One of the interesting problems connected with the theory of consumer behavior is the existence of goods which are more in demand as the price rises – the so-called Giffen goods. Professor Y. Kannai has shown that with the assumption of a concave utility function for the consumers' preference, an upper bound may be found for the own-price difference quotient. This is an extension to the previous work by Jordan that prohibited jumps in the Giffen direction for concave utility functions (Hurwicz et. al., 1987). Kannai has also published work on the relationship of Engel curves, marginal utility of income, and conceivable preferences.

Operator or Estimation Theory. Professor H. Dym's principal activity is in the area of reproducing kernel spaces. A mathematical representation of such kernels is given in the equation

$$< f, k > = f(w)$$

Although this representation appears somewhat abstract, the theory has direct application to approximation theories in terms of Hankel operators in current control theory based on H^{∞} methods. In fact, Dym's research is the study of approximation methods in the abstract. In a recent paper, Dym (Alpay and Dym, 1986) has applied reproducing kernel spaces to the Schur algorithm. Dym is presently writing a monogram on reproducing kernels.

Control and Optimization. Dr. Z Artstein is studying the stabilization of nonlinear systems using state variable feedback. In a recent publication he has considered the use of Liapunov functions for time varying and controlled equations (Artstein, 1986). As an example of the strong interaction with groups in the US, which I found characteristic of the Weizmann Institute, Artstein, in collaboration with R. Wets of the University of California, Davis, is also involved in a study concerning stochastic optimization. They are investigating convergence properties and approximations by sampling.

Applied Mathematics

Feedback Systems. When I visited the institute, Professor I. Horowitz, who has made substantial contributions to the field of control theory, was at the University of California, Davis, where he has an appointment. (Many of the people that I talked to in Israel about control theory were former students of Horowitz, who is well known for his classical book on feedback systems.) I talked to two of his doctoral students, S. Oldak and M. Kelemen.

Kelemen is presently investigating distributed linear systems (for example, heat equation) and has obtained a new bounded-input bounded-output (BIBO) stability criterion and has also studied the effect of discrete feedback on the system. Horowitz' recent work in multi-input multi-output (MIMO) systems is of fundamental importance (Horowitz et. al., 1986). The design method developed by Horowitz and his students is based on successive single loop design with no iterations necessary. The original procedure was confined to minimum phase systems. The present extension is to non-minimum-phase systems with unstable plants and is thus a significant improvement in the design method. Non-minimium-phase (NMP) systems constrain the MIMO feedback systems in which they are embedded and are often encountered in aircraft MIMO control systems. Horowitz has shown that not all the disturbance response function need be con-

strained and that one can develop a consistent design procedure for MIMO systems that handles the restrictions. Horowitz' previously developed design procedure for minimum phase systems has been nicely extended to handle the NMP system.

Robotics and Vision. Dr. Tamar Flash leads the effort in robotics and vision (which typically is in an electrical or mechanical engineering department). There appears to be an increasing emphasis on this work in the department's applied mathematics projects. Flash's research is directed at analytic and numeric investigation of robots' contact tasks, including elasticity and compliance in the robots' joints. She is particularly interested in smooth or graceful motion, as might be typified by a human subject (Hogan and Flash, 1987). In what I think is a clever approach, Flash defines the smoothness of the motion as the minimization of the integral of the jerk (derivative of the acceleration) over the duration of the motion. Her work has been primarily directed at the analysis of human multijoint motor behavior, but she is presently extending the concepts developed there to robotic motion. The vision work is perhaps more pragmatic and typical of robotic vision problems concerned with object recognition, grey scale, and depth and motion perception.

Fluid Mechanics. Professor Achi Brandt is well known for his research in multigrid methods. That research (Brandt, 1987) has been funded both by the US Air Force and by the US Army. He has 10 research students working on multigrid methods. Some of his recent results include a rigorous theoretical framework to justify local mode analysis, new approaches for high Reynolds number and shock flows, a nonstaggered but stable desensitization of the Stokes equations, and an increased efficiency for statistical physic calculations by means of multilevel Monte-Carlo methods. Brandt's multigrid approach is not limited just to fluid mechanics equations – he is extending the application of the multigrid method to a wide series of equations such as, for example, the Dirac equations in gauge fields.

Dr. M. Magen's main field of research is in linear and nonlinear stability theory as applied to fluid mechanics. His work in stratified flows was motivated by analysis that he developed for solar ponds where convection effects can lead to a considerable decrease in the amount of energy that can be extracted from the pond. His in-process stratified flow work is concerned with linear stability in channels with wavy walls. Poiselle flow shows experimental instability in the range of a Reynolds number of 1000, while theoretical predictions are in the range of Reynolds number of 5700. Numerical calculations for a wavy wall with Poiselle flow yield a minimum Reynolds number of 1000 – an intriguing result. Other recent work of his is in double diffusion processes (Magen et. al., 1988).

Theoretical Biology. Professor L. Segel, head of the applied mathematics activity, is concerned with the modeling of complex biological systems and responses (Knox et. al., 1986). One could term his research as being in the field of molecular and biological ecology. His recent work has been the development of a complete receptor model of the cellular slime mold which has been very successful in describing state passivity, secretion, and oscillatory behavior. His other recent work is directed at what could be termed computational immunology. The modeling must represent the immune system, which is resistant to perturbations but not too resistant. One must have a control and stability tradeoff. Generalized shapes are used as the fundamental descriptive variable. This latter work may have some relevance to AIDS research.

Conclusion

I. Horowitz's research in control theory is world class and his recently developed MIMO methods of design are being supported by the US Air Force. Horowitz's methods are intuitively brilliant in their very simplicity.

A. Brandt is an international authority in multigrid methods, and many of the advances in multigrid methods have been developed by Brandt and his students. His group is a world center of excellence in this area.

The other research reviewed in thise article concerns important problems. Many of the staff have spent long years in America and some are transplanted Americans. Seeing this type of close international exchange, one is not surprised to find high-quality research as a result.

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7/25/88

PHYSICS

Some Novel Magnetic Materials are Studied at Oviedo

by Paul Roman. Dr. Roman was the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office from September 1984 to September 1988.

The University of Oviedo in the Asturias region of northern Spain, originally built in 1598, is one of the latest provincial institutions of higher learning that caught the attention of the intensive research-buildup program of the Spanish government. The science faculty recently received several new senior positions and, for example, the Physics Department initiated a full and varied professional physics degree curriculum, including a Ph.D. program. It is too early to see how this development will work out (in my opinion, it will fail), but the Physics Department, under the leadership of Professor M. Tejedor, has established its competence in at least one area: the study and application of novel magnetic materials. A brief review follows.

Magnetoelastic Materials and Torque Magnetometers

Torsioned magnetic ribbons received much interest in the past few years. Due to their good elastic and magnetoelastic properties these ribbons show many interesting effects and promise new practical applications.

One of the phenomena the Oviedo physicists focused on is the inverse Wiedemann effect (IWE). When a torsional strain is applied to a magnetostrictive ribbon, as a result of the torsional stress the preferential ("easy") direction of magnetization is shifted into a helical path. If a magnetic field H_ϕ is circularly applied (simply by injecting a current through the ribbon) the ribbon is magnetized both longitudinally and circularly. This appearance of a longitudinal magnetization, Mz, is called IWE.

Tejedor pointed out that this magnetization can be detected by a secondary coil wound around the ribbon. If an alternating current is used, then the voltage, V, obtained by integrating the EMF induced in the secondary coil is proportional to Mz. In fact, the first work done with magnetic ribbons in Oviedo was precisely the use of this mechanism for constructing and carefully testing a new magnetoelastic torque magnetometer. The researchers used primarily amorphous ribbons, such as Metglas 2826 (i.e., $Fe_{40}Ni_{40}P_{14}B_6$). The construction is that of a torque magnetometer of the fiber-suspension type, in which the magnetostrictive ribbon replaces the torsion wire that supports the sample. Since IWE in the twisted ribbon gives a large signal for even extremely slight torsions, this kind of magnetometer has very high sensitivity compared to the classical types. In addition, the mechanical construction is simple. The measuring process can be easily automated.

One of the first applications of this new magnetoelastic torque magnetometer was, ironically, the careful study of the IWE itself. Apparently, before the work at Oviedo, very little was known about the IWE for extremely low torsions. Tejedor's group considered torsions in the range -1.75 to + 1.75 rad/m. They compared the behavior of the amorphous Metglas 2826 with that of the polycrystalline Deltamax (i.e., $Fe_{50}Ni_{50}$). For the latter, they observed a strict linear variation of the magnetization M_z as a function of incremental torsion change. But for the amorphous ribbon (Metglas), more irregular behavior was found. Not only is the variation of M_z deviating from strict linearity, but it also shows sudden abrupt changes. This behavior can be traced to the known irregular distribution of anisotropy in these materials.

In another series of experiments, still in the above *low-torsion regime, the scientists studied the effect of the* intensity and frequency of the exciting current, of initial torsion, and of applied tension. Exact knowledge of these effects is needed for ultrasensitive magnetoelastic torque magnetometers.

In order to facilitate the use of novel magnetic amorphous ribbons in a variety of technology applications, in 1987 Tejedor and coworkers started a new series of experiments aimed at the measurement of the saturation magnetization and the magnetic anisotropies of such ribbons. So far, five different Metglases (including the 2826) and $Fe_{80}B_{20}$ were studied. The measurements were made with a home-developed new torque magnetometer (originally developed for the study of thin magnetic films). The main characteristic of this instrument is that for counteraction it employs the torque exerted on the sample in the same field which is used for exciting the sample.

Research on Thin Magnetic Films

Magnetic amorphous ribbons obtained by quenching have geometrical characteristics similar to those of magnetic films. Thus, it is not surprising that the Oviedo physicists have an ongoing program for the study of thin magnetic films as well.

In one study, an experimental device has been developed to study the magnetic properties of vacuum-

evaporated amorphous thin rare-earth/transition-metal films. The apparatus permitted the *in situ* measurement of the in-plane magnetization (i.e. a measurement done while the samples is still in the vacuum deposition system), as well as its measurement when the sample was removed into the atmosphere. The in-plane magnetization curves were determined via the magneto-optical transversal Kerr effect. In the initial experiments, the film material was of the Tb_xFe_{1-x} type, and its thickness was of the order of 100 nm. A wealth of data have been obtained. The most interesting result was that remarkable changes occur in the saturation magnetization, the initial permeability, and the coercivity, immediately after the samples were exposed to the ambient air. It was concluded that these changes are due to the preferential oxidation of the rare earth.

Currently, the Tb-Fe films are replaced by more interesting, rare-earth/transition-metal systems and in fact, other experiments are also carried out with such ultrathin magnetic films, aimed at the very accurate determination of their chemical composition. (This is important for process-control, since very minute changes in the rare earth content bring about enormous changes in the magnetic behavior characteristics.) The very sensitive analysis was done by the method of inductively coupled plasma optical-emission spectrometry. The work was performed in cooperation with the local Department of Analytical Chemistry.

Uncompleted and Future Research

Another new line of research in progress led to observing substantial differences between bulk and surface magnetization of amorphous magnetic ribbon materials. No clearcut explanation is yet available.

Future planned work includes the study of phase transitions (crystalline-amorphous and other) as manifested by the change of magnetic properties of a sample that is affixed to one of their supersensitive torsion magnetometers. At the moment of this writing, the checking-out and the calibration of the apparatus is making good progress.

Summary

The Oviedo magnetics group has shown much initiative in building up a modest, but important niche of research where they can successfully compete with larger institutions. Their policy is to go into depth in the areas they cover. Another remarkable feature is the clever and inventive use of very modest, often home-built equipment which, coupled with a cheerful spirit, maintains momentum.

8/10/88

A European Conference on Applied Laser Technologies

by Paul Roman.

Laser engineering is now emerging as an autonomous field, and novel laser applications are percolating into many areas of science, technology, and defense. No wonder that the industrial leadership of Europe is vigorously increasing its support of applied laser technology. This interest was well represented by the conference entitled "Laser Technologies in Industry" which, rather significantly, took place in a promising developing country: it was held from 5 through 8 June in Oporto, Northern Portugal. The primary sponsor was the Directorate-General for Telecommunications, Information-Industries, and Innovation of the European Economic Community (EEC, DG XIII.) The Portuguese Physical Society, the Portuguese National Council for Scientific and Technologic Research, the European Physical Society, and the International Society for Optical Engineering (SPIE) also took leading roles; and a very large number of Portuguese (as well as international) private industrial and nonprofit organizations contributed funds. (So did the European Research Office of the US Army.)

It may shed light on the increasing interest of Europe in very practical laser applications that this meeting had two predecessors (in 1985 and 1986), each of which was attended by less than 40 people. The present conference, in contrast, attracted about 300 participants – and had there not been an organizational flaw concerning accommodations which resulted in a large number of cancellations, the conference would have been even larger. Even so, the 300 participants represented 30 countries (with, fortunately, an overwhelming European component), and about 165 papers were accepted by the organizers. (However, because of the noted cancellations, a large portion of these was not read.) The proceedings are expected to comprise about 1300 pages.

Inevitably, the conference had to be split up into four, parallel running streams. These were, roughly speaking, the following areas:

- General considerations on applied laser technology
- Optical metrology
- Laser-based sensorics
- Laser processing, and applications in robotics/automation.

There were also three plenary sessions attempting interdisciplinary reviews of modern industrial laser applications, optical methods in metrology, and material processing with lasers. (The presenters were A.J. De Maria [United Technologies Research Center, US]; J. Ebbeni [Free University, Brussels, Belgium]; and A. Sona [CISE, Milan, Italy], respectively.) The conference proper was followed by two workshops: one on lasers in medicine, and a tentative one on laser technologies in ocean sciences. There was also a modest exhibition (with about 10 exhibitors) accompanying the conference.

Since SPIE undertook to publish the entire proceedings (Vol. 952 Part A and Part B) in its well-known conference proceedings series (available, probably toward the end of 1988, from SPIE, PO Box 10, Bellingham, WA, 98227-0010), there is not much point in giving a detailed report. Therefore I have written only brief comments on only a select few contributions to laser-based sensorics and optical metrology.

Optical Measuring and Sensing

Following two invited overview-papers on the state-of-the-art of integrated optical sensors and optical fiber sensors, B. Culshaw (University of Strathclyde, UK) gave a strong personal view of the practice and possibilities of fiber-optic sensors. He analyzed the bewildering variety of techniques that are now available for measuring almost all imaginable physical (and many chemical) parameters, and concluded that certain balanced sensor *families* are likely to emerge in the near future. These will focus on the more promising techniques, while other approaches may wither.

K. Baucklage, on behalf of a group at the University of Bremen, West Germany, gave an interesting description of how one can use fast-Fourier-transform methodology for the phase-Doppler-difference analysis of, for instance, powder metal sprays.

A. Boxman and B. Scarlett (Technical University of Delft, the Netherlands) reviewed recent research that permits on-line measurement of crystal size and shape, using a combination of various optical techniques.

An amazing number of contributions addressed various problems in the area of laser Doppler anemometry, including phase-Doppler-techniques for the simultaneous measurement of particle velocity and particle size.

Holography

Another substantial group of contributions focused on holographic optical elements. For example, in a presentation by A. Fimia (the Spanish Inter-University Research Group for Optics, Section at Alicante, Spain) analyzed the influences of developer and of bleaching in regard to diffraction efficiency and noise, when silver-halide-sensitized gelatin is used for manufacturing of transmission-holographic elements.

C.G. Stojanoff (Ruhr-Westphalen Technical University, Aachen, West Germany), described how his research group used miniaturized holographic optical elements to substantially improve laser Doppler optics techniques.

Moiré-holographic gratings for use in the area of structural analysis were the topic of a presentation from the Technical University of Cagliari, Italy, summarized by F. Ginesu.

A. Ettenmeyer (Rottenkolber Holo-Systems GmbH, West Germany) contributed a fine evaluative review of all extant techniques that may be used to extract, by automatic computer methods, maximal information from holographic-interferometric images.

A well-constructed review by D. Vukicovic reported on cooperative research done by the University of Zagreb (Yugoslavia) and the Technical University of Graz (Austria). It described an advanced holographic data-reduction procedure for the tomographic study of convective heat transport. (Of course, other applications of the methodology should be quite possible.)

Finally, I want to mention that there was a related set of papers which discussed aspects of computer aided holography.

Concluding Remarks

This conference surveyed quite well current European preoccupations in applied laser technology and provided a useful forum for exchange of thought. Indeed, presentations were informative (most lasted 30 minutes, some were given 1 full hour.) The atmosphere, provided by the modern building of the Faculty of Economics at the rapidly developing University of Porto, was pleasant – and people good-humoredly put up with quite disturbing disorganizational hardships.

7/21/88

Optoelectronic Device Technology–an ONRL-Supported Symposium Session

by Paul Roman.

"Optoelectronics: 1990 and Beyond" was an invitation-only symposium on the future of developments and applications of optoelectronics. It was held in Kilarney, Ireland, from 22 through 26 May 1988. There were 160 delegates attending; apart from Europe, the US and Japan were heavily represented; there were also participants from the USSR, China, and South America. An attraction of the meeting was the presence of several technical directors of the major optoelectronics companies (including, for example, from Europe, Siemens, Philips, Plessey, and British Telecom). The symposium, honoring Professor Daniel J. Bradley, FRS, Trinity College, Dublin, was co-organized by Imperial College, London, Trinity College, Dublin, and the MIT Lincoln Laboratories. Financial support came from a large number of organizations, including multinational industry.

Three sessions on optoelectronic device technology, occupying almost all of a very busy day, were sponsored by the London Branch Office the US Office of Naval Research. I review briefly a few selected papers given in these ONRL-supported sessions.

The opening address was given by W. Stewart, Research Director of Plessey Research, Towcester, UK. He made two interesting points. First, that because of current trends for more precision control, for more efficiency, and for smaller size and integration – as well as because of falling costs – complex systems are becoming more practical as well as more stable. Second, he noted, light is the most easily accessible quantum effect, and there is evidence of a long-term trend towards using quantum effects in systems. In particular, Stewart believes that close confinement of light will make the use of nonlinear effects more and more feasible.

F. Auracher, head of the solid-state electronics laboratory of Siemens, Neuperlach, West Germany, talked about application-driven R&D in optoelectronics at Siemens. He indicated future trends of fiber-optic communications systems for the subscriber-area and for the longhaul trunk systems, and discussed implications for device development. By way of examples typical of the present status of important components, he mentioned high-reliability lasers for 1.3 and 1.5 μm, high-performance detectors, a monolithically integrated PIN-FET circuit, and a DFB-laser with an integrated optical waveguide.

Electro-optical systems for use in optical memories were the topic of the talk given by B. Bolger, senior scientist of the Philips Research Laboratories, Eindhoven, the Netherlands. After a review of various techniques, he focused on the use of phase-change-materials. He considered the task of improving information density, and concluded that the clue lies in going to shorter wavelengths. Bolger finally summarized the important requirements for the future: (1) fabrication of a diffraction-limited lightsource in the blue (not necessarily monomode), (2) technology for efficient second harmonic generation from 820-nm sources, and (3) improving of detector efficiency at 410 nm and of cheap objective lenses.

The research director of Barr & Stroud Ltd., UK, surveyed optoelectronic device development in the Pilkington Group. He considered results in the areas of materials, devices, and systems. He said that "the future lies with" nonlinear polymers, flat-screen electroluminescent visual display units, laser-radar systems, and optical disc storage.

In addition to the above talks from European centers, there was a contribution from Japan (S. Miyaoka, Director, Sony Technical Laboratory, Tokyo) evaluating optical recording versus magnetic recording. Finally, there were also four talks by American researchers (not supported from ONRL funds).

The symposium ended with a lively discussion session which also covered areas of optoelectronic device technology. The major conclusions of this discussion appear to be the following:

In the 1990's switching will still be done with semiconductor lasers generating picosecond pulses but switched with electro-optics. Nonlinear optical devices will be important but not in the near future. Semiconductor lasers will find many more applications. Optical interconnects, optical data storage, and diode-pumped solid-state lasers are here, and fibers will find many more uses as active elements. The present bottleneck is in spatial light modulators and nonlinear optical materials.

8/2/88

SENSORS

A Sensor-Event in Nuremberg

by Paul Roman.

"Sensor 88," a comprehensive biennial West German event in the area of sensorics, took place this year in Nuremberg, 3 through 5 May. As on the preceding three occasions, the activities were initiated by the German Society for Transducer Technology (AMA), and cosponsored by six other international organizations. The venue of all Sensor 88 events was the excellent, well-equipped Exhibition Center just outside (but within easy reach) of Nuremberg.

The core of the huge international get-together was undoubtedly the exhibition, which occupied three buildings with a total area of 15,000 square meters. More than 600 companies from 14 countries had stands. The entire spectrum of sensorics (including the relevant electronics) was well represented, from sensor elements through transducers to complete systems and installations. Accompanying this product-oriented exhibition, a "Special Show" also took place. This allowed universities, research institutes, and industrial research and development laboratories to present their current and planned interests in sensorics (and in the associated industrial microelectronics). Thus, this show served as an information forum for developers and decision makers, and resulted in technology transfer activities. I found it an excellent idea which should also be highly recommended for organizers of other exhibitions.

The scholarly focus of Sensor 88 was the Congress, which was attended by about 560 participants and which consisted of three, independent streams: science, technology forecasts, and marketing. The science stream (the one about which I shall comment) presented 76 talks (in two parallel, well-delineated sessions); each talk was concise (20 minutes, including discussions) and of high level. The majority of the speakers were German, but there were also many British and French speakers, as well as representatives from communist countries. The talks were grouped as follows:

1. Fundamentals: new sensors and new sensor materials
2. Special problems in sensor and sensor-system development
3. Temperature measurements (2 sessions)
4. Chemical sensors (2 sessions)
5. Velocity and flow measurement (2 sessions)
6. Force and acceleration measurement (2 sessions)
7. Pressure measurement (2 sessions)
8. Distance measurement (2 sessions)
9. Optical sensors and optical measuring techniques (2 sessions)
10. Miscellaneous applications.

There was also a poster session with 25 presentations, neatly set aside from the main body of the meetings (a blessing).

I have selected, somewhat idiosyncratically, only a few talks from areas 1, 4, 7, and 9, hoping that they are sufficiently representative of current trends in sensor-science.

Some New Methods and Materials

The keynote address in this area was given by K.-W. Bonfig (University of Siegen, West Germany), who described vividly the merits of direct digital measurement (DDM) techniques. DDM allows the precise determination of an entity by a measuring device, with high noise suppression and a minimal number of device or system components. This is made possible by the use of microprocessor technology. Tolerance of the metering circuit, influence of offsets, drifts, etc. are largely eliminated. Focusing on his colleagues' recent experiments, Bonfig explained that a microprocessor is used to generate an auxiliary signal with digital, pseudo-random time-behavior. This auxiliary signal is combined with the output of the measuring device, whose analog signal is read by the microprocessor, using an analog-to-digital converter. The components of the final signal that originate from the known auxiliary signal are then filtered out by correlation analysis, and thus the true measurand can be determined, free of many disturbances.

The next two talks described the use of novel materials.

D. Halvorsen (Pennwalt Corporation, Edinburgh, UK) talked about the use of new piezoelectric *and* pyroelectric plastic films made from poly-vinylidene fluoride (PVDF). This material lends itself to a large number of control and monitoring applications. PVDF is distinguished by ease of fabrication, and devices based on it are lightweight and shatter-resistant. One of the most exciting uses of PVDF sensors is in the area of hydrophones. Pressure sensors for shockwave studies, infrared sensors, vibration sensors, switching devices, robotic tactile sensors, and medical monitors are other promising areas of application.

M. Piso and colleagues (Research and Development Institute for Electrical Engineering, Bucharest, Romania) talked about the application of magnetofluidic materials. Actually two areas, only vaguely related, were covered in the talk. A microcomputer-controlled magnetofluidic passive three-axis accelerometer was one topic; general considerations on the use of magnetofluidic systems as an active medium for sensors (including an accelerometer) was discussed in the second half of the exposition.

Chemical Sensors

W. Neu, representing a group of researchers from the University of Tübingen (West Germany) opened the session with a review of recent work concerning studies of prototype inorganic and organic solidstate chemical sensor materials used for gas detection. Their research employed a "multimethod interface analysis" technique, which combined phenomenological and spectroscopic approaches, and used both ultrahigh-vacuum and high-pressure environments. As a result of these studies, the researchers produced and optimized an SnO_2 sensor for NO_2 detection. Other in-depth studies aimed at the understanding of the gas-sensing mechanism involving phtalocyanin (used for O_2 and NO_2 detection.) In a related experiment, phtalocyanin was used to coat ionic conductors (like AgJ); in this manner, new sensors of remarkable properties were produced.

Another talk in the session on chemical sensors that caught my attention was given by G. Gauglitz, also from the University of Tübingen. Unlike the usual talks on chemical sensing, this work presented a dynamical study of photochemical processes in thin layers of photoresists. The crucial element in the research was the development of a suitable reflectance-spectroscopy measurement system. Apart from shedding light on the photochemistry in thin layers, this method can be used to improve present (entirely empirical) industrial procedures for microstructuring circuit boards and semiconductor wafers.

Pressure Measurement

Shi Jinshan (Yan Shan University, Peoples Republic of China) reported on the development of a new, very high sensitivity pressure transducer with optical fiber data link. "The ingenious design" of the transducer (as the speaker referred to it) uses a flat diaphragm of sensing differential capacitors, whose capacitance changes the width of the pulsed signal. Pulse position modulation is employed, so as to avoid instability effects.

A new family of silicon pressure sensors was described by H. Kuisma (Vaisala OY Company, Helsinki, Finland). Actually, the Vaisala researchers developed two basic structures: (1) A vacuum- isolated absolute pressure sensor consisting of a silicon diaphragm and a glass-covered silicon support-plate, and (2) a more complicated structure, consisting of a diaphragm, a cover plate on one side, and a base plate with a stationary electrode on the other side of the diaphragm. Both types can be scaled well from very low to medium pressures. The second type can be configured so as to act as an absolute, a gauge, or a differential pressure sensor.

Optical Sensors and Measurement Techniques

The keynote address, a tutorial introduction reviewing technologies for the fabrication of integrated-optics devices on a glass substrate, was presented by A. Brandenburg (Fraunhofer Institute for Measurement Technology, Freiburg, West Germany). He gave a very clear description of both the thermal and the ion-exchange methods for waveguide formation, and concluded with some applications of such devices as sensors or as sensor-components.

A group of researchers from the University of Paderborn (West Germany), represented by W. Sohler, described an interesting computer-controlled system for optical gas analysis. The system uses optical fibers for remote sensing. An integrated optical parametric oscillator (IOPO) serves as a source for near-infrared radiation (between 1.0 μm and 1.6 μm.) Differential absorption spectroscopy accomplishes the determination of various gas components (mainly methane and HCl were used in the experiments.) The IOPO is continuously tunable; it has a spectral linewidth less than 0.7 cm^{-1}, and an output of several mW. The detection limit and the selectivity of optical gas analysis will be much improved by use of this system since the luminous power density of this advanced integrated optical device exceeds that of a light-emitting diode by several orders of magnitude.

A very careful discussion of signal processing for optical-fiber Fabry-Perot (FFP) sensors was presented by H. Wölfelschneider from the Freiburg Fraunhofer Institute. He paid particular attention to the transmission-line-insensitivity problem of the evaluation methods. He concluded by indicating that his studies may serve an important role in the future development of multiplexed signal processing systems, suitable for simultaneous handling of several FFP-based sensors, even if these ascertain different measurands.

Finally, I mention the presentation by H. Höfler (also from the Freiburg institute) who described a diode-laser-based interferometer, suitable for supersensitive measurement of displacements. The major problem in the use of a diode laser in the interferometer was its stabilization. The usual thermal- and current-stabilizing methods were found inadequate, and the difficulty was

overcome by the use of a simultaneous index-of-refraction compensation technique.

I find it amusing that, in this section on optical sensors, all talks I found interesting came from West German institutes; in fact, three of them from the same place. This cannot be fully explained by my prejudices: looking at the program I note that out of the eight talks in this area, six came from German researches (and, equally interesting, the remaining two from the UK.)

Concluding Remarks

This was a quiet, well-organized, low-key conference, and the attendant exhibition was first class. It appears that European (and especially German) sensor know-how has reached a very high level.

I have two huge volumes containing the texts of all talks; I would be glad to send to interested, qualified readers a copy of the table of contents, and later, copies (of a moderate number) of texts. A warning: most papers are in German. [Address requests to ESNIB editor.]

I also have a rather lengthy exhibition catalog and a short list of exhibitors. Likewise, a list of all conference participants (with affiliations but not postal addresses) is also available.

7/21/88

SPACE SCIENCE

IEE Meeting of HF Radio Systems and Techniques

by John M. Goodman. Dr. Goodman is a scientist working on ionospheric effects for Space Science Division of the Naval Research Laboratory, Washington, DC.

Introduction

The 4th International Conference on Radio Systems and Techniques was held in London, UK, from 11 through 14 April 1988 at the historic IEE Headquarters and Lecture Hall near Whitehall in the Westminster district – the same location as the previous three conferences (1979, 1982, and 1985) which dealt strictly with HF communication systems and techniques. The agenda for this 4th conference was broadened to include meteor burst communications and surveillance topics. As is becoming typical in most topical conferences of this type, a conference preprint digest of the papers was made available to the attendees upon – and even before – registration. (It is available now through IEE, Savoy Place, London WC2, UK. Title: "HF Radio Systems and Techniques" the Fourth International Conference, Publication No. 284.) There were nine UK members on the organizing committee and seven overseas members, including myself.

The number and origin of the attendees indicates the renewed level of interest in HF, which was once thought to have been outmoded in its role as an important communications medium. Attendees from the UK numbered 159, from the US, 34, Sweden (21), France (17), West Germany (16), Denmark (10), Canada (9), and 18 from other countries (65).

The meeting was broken into a number of sessions, and because of the number of offerings, the sessions were run in parallel after the first day.

Session topics and number of sessions in each were:

- System design control and networking (7)
- Antennas (3)
- Noise, interference, and modeling (1)
- Propagation (2)
- RF equipment and techniques (3)
- HF radar (3)
- Signal design and processing (4).

Summary of the Presentations

System Design, Control, and Networking. This topic provided the greatest number of contributions at the conference with 23 papers being published in the preprint. Unfortunately, two of papers were withdrawn at the time of presentation.

The common feature in most of the papers was the increased importance of so-called adaptive HF as opposed to traditional static approaches using long-term predictions of channel performance. Adaptivity was discussed in the context of link protocols, signal processing techniques, and FEC/ARQ approaches in error correction. (FEC stands for Forward Error Correction and ARQ is short for Automatic Request for Message Repeat.) There is the recognition that HF communication

performance can be improved overall if an attempt is made to match data rate to the time-varying channel capacity. In a crude way, the ARQ scheme is an approximation to this idea. The process of adaptivity is dependent upon either an explicit or implicit knowledge about the channel. The methods for real-time-channel-evaluation (RTCE) were discussed in this session as a way to obtain knowledge about the range of variability of the channel parameters over which the system must be designed to adapt. Fundamental changes in how we view HF performance obtains if we acknowledge channel variability, sense it, and match the system parameters to the channel. This view has long been expressed by Professor Darnell of Hull University, who was the chairman of the first two sessions and has been a leader in characterizing types of RTCE schemes.

Also covered was the issue of spatial and temporal extrapolation of parameters derived from oblique sounders. As would be expected, the problem of frequency management is a major problem at HF because of the relatively small number of 3-kHz channels available from 3-30 MHz, the large number of worldwide users of the band, and propagation constraints. Several papers dealt with adaptive frequency management.

A paper by myself and M. Daehler, also of the Naval Research Laboratory, dealt with the issue of spatial and temporal extrapolation of Oblique-Incidence-Sounder (OIS) observables. This matter is important in connection with the efficient use of already-deployed OIS assets and in the exploitation of such data in denied areas.

Two papers on meteor burst were presented at the conference, and they were placed in the topic category of system design, control, and networking. The UK system, "Blossom," was covered by authors representing the Royal Aircraft Establishment (RAE). Meteor burst is, of course, viewed as an extension to HF and has special value in a highly stressed environment during which the normal ionosphere is disturbed.

Antennas. The importance of antenna selection and design was acknowledged in three sessions at the conference. Of particular interest were two papers by the SRI International (California) group dealing with the reduction of skywave and groundwave interference; these were by O.G. Villard and B. Hagn, et al., respectively.

Large broadcast antennas were covered in two papers, as were specific aspects of near-vertical-incidence-skywave (NVIS) antennas. A group from C&S Antennas Ltd. in the UK discussed a wideband transportable NVIS antenna system.

Noise, Interference, and Modeling. One of the central problems in HF communications is the ambient noise and interference environment. The conference had several papers dealing with spectral occupancy, emphasizing the European area where HF use is most dense. Of special note was a new model on spectral occupancy being developed by G. Gott and his colleagues at the University of Manchester, Institute of Science and Technology (UK). The concept of interference excision and a model of wideband interference and noise was presented by B.D. Perry and L.G. Abraham of the Mitre Corporation, US.

Propagation. An HF conference would not be worthy of the name without some consideration of propagation on the technical program. The general topic of propagation permeated the entire agenda, but the program committee identified four papers which were particularly worthy of note. The first, presented by J. Ostergaard of Electronikcentralen (Denmark), dealt with short-range communications in the high-latitude regime. This paper dealt with the fundamental problems encountered in trying to communicate in the arctic environment. Data obtained in northern Greenland were presented which seemed to bear out CCIR-method predictions of median critical frequencies; however, the noise and interference levels were much lower than predicted. It was found that low-noise receivers may have some value in the lower part of the HF band for NVIS propagation – a frequency regime where one is typically limited by ambient noise (at least at lower latitudes). The second paper of special interest was presented by two Belgians: D.L.R. Van Troyen, Kotholieke Industriele Hogeschool de Nayer, and A.R. Van de Capella, Katholieke Universiteit, Leuven, who used oblique-incidence-sounder data in conjunction with the MINIMUF model to predict median values of foF2 several months in advance. In doing this the group concluded that the performance of such an algorithm was generally better than standard models, such as the CCIR method, IONCAP, or MINIMUF when driven only by a sunspot number. The reader is cautioned however, that this method pertains only to the forecast of median values.

RF Equipment and Techniques. Nine papers were given in the general topic area entitled "RF Equipment and Techniques." The Naval Research Laboratory group, which had contributed heavily in this topical area in the previous conference, had but a single paper this time around, possibly symptomatic of the cuts being offered by the US Navy HFAJ program. This paper on low-distortion RF component technology development by Ed Barr and his colleagues was nevertheless quite interesting. Other papers dealt with DSP techniques, an automatic signal classification scheme, coding, signal separation, and DF techniques.

HF Radar. One of the new topics of the current IEE conference, HF radar, drew a considerable amount of attention. HF radar developments were discussed by groups from the UK, China, France, and Australia. The Marconi and University of Birmingham groups in the UK presented four papers dealing with HF surface-wave

radar, while two French papers dealt with skywave radar and backscatter sounding for ionospheric modeling.

Signal Design and Processing. Thirteen papers were presented in the general area of signal design and processing. The US contributions included a paper by S. Dutta from the Collins Defense Communication Corporation on a null-steering adaptive array processor for voiceband HF links, and a paper by D.D. McRae and F.A. Perkins of the Harris Incorporated on modem evaluation using simulators. An excellent paper was presented by J. Pennington of the SHAPE Technical Center describing a set of interference tests on HF modems. It is clear that the development of more robust (and possibly adaptive) modem designs will dominate the worldwide HF improvement initiatives for some time to come, and a number of papers were presented outlining these new techniques. The major thrust would appear to be in the development of digital models capable of transmitting data at 25,400 to 4,800 bps using serial techniques in the presence of noise and interference. A good example of these newer approaches is found in the work by J.M. Perl and coworkers at Tadaran Ltd. in Israel.

Summary

The recent edition of the EE conference on HF systems and techniques has shown that HF as an RF band is not obsolete, and that exciting new developments are leading to a new perception of HF. Modern HF systems will have enhanced reliabilities, placing them in a more competitive position as a viable communications method in the future. As most workers are well aware, HF has been neglected in recent years as a result of an overzealous commitment to satellites. Much of this neglect is no doubt deserved because of the unpredictable, hostile nature of the ionospheric medium upon which the HF skywave so dramatically depends. New technology is changing much of this, allowing us to take advantage of the virtues of the ionosphere – and there are some – while compensating for the vulnerabilities of the HF energy. As was indicated by an anonymous attendee in jest, SATCOM may soon be considered as a backup to HF, and further, that meteor burst would give the satellite-based systems a run for their money – even as backup.

7/11/88

Aurora Conference in Honor of Sidney Chapman Outlines Future Auroral Missions

by R.L. Carovillano. Dr. Carovillano is a Professor of Physics at Boston College. He is a former Liaison Scientist (1982 through 1984) for the Office of Naval Research's Branch Office, London.

The International Conference on Auroral Physics was held from 11 through 15 July 1988 at St. John's College, Cambridge, UK. The conference was dedicated to the late Sidney Chapman in celebration of the centenary of his birth and in recognition of the indelible imprint made on the field through his own scientific writings and acknowledged influence on many scientists prominent in the field.

Auroral Science is highly interdisciplinary, involving space physics, atomic and molecular physics, chemistry, plasma physics, and ionospheric physics. The format of the conference was to have invited talks, for review or tutorial purposes, and original contributions in a poster session. The final session was a look into future national programs in auroral research. Young scientists were encouraged to attend the conference, and virtually all requests for financial aid were met at least in part by the convenors, Dr. L.A. Frank (University of Iowa), Dr. C.I. Meng (The Johns Hopkins University, Applied Physics Laboratory [APL]), and Dr. M.J. Rycroft (British Antarctic Survey). About 150 scientists from 15 countries attended the conference. The US had the largest representation (61) followed by the UK (29) and Canada (12). The US total equaled that of Europe (58) plus the USSR (3). Japan had seven representatives and, surprisingly, South Africa six.

The aurora is a complicated geophysical phenomena that occurs in both hemispheres at high geomagnetic latitudes. Auroral light is very faint, a medium brightness being less than 10^{-6} that of sunlight, and much auroral activity is actually subvisual. Ground-based spectroscopy was the main source of information in the early days of auroral research and is still a valuable tool. Rockets and satellites are needed, however, to probe the detailed processes that take place, observe the particles that precipitate from above, and image the aurora on a global scale.

In current research, the aurora is observed and monitored by a variety of ground-based and satellite techniques. Ground-based methods include all-sky cameras and other optical techniques, magnetometers, ionosonders, riometers, radar systems and pulsation measure-

ments. Satellite observations include precipitating particles, auroral imagery on microscopic and even global scales, electric and magnetic fields, waves, and kilometric radiation. The invited sessions of the conference reflected the many areas of active auroral research:

- Auroral Spectroscopy
- Auroral Particles and Acceleration Mechanisms
- Auroral and the Magnetospheric Configuration
- Auroral Substorms and Dynamics
- Auroral Structures
- Auroras and the Ionosphere
- Auroras and the Thermosphere
- Directions of Future Research.

The categories of the contributed papers (a total of 85) were: Spectroscopy; Particle Precipitation and Waves; Morphology, Substorms, and Configurations; Currents, Ionosphere and Thermosphere; and Theoretical Papers. A book on the proceedings based on the invited talks is planned for publication with the Cambridge University Press in about a year.

I have organized this report on the basis of presentations on the auroral programs and plans by the country or region – the US, the USSR, Western Europe, and Japan – which the speakers represented.

Review of US Auroral Research

D. J. Williams (Johns Hopkins University, APL) spoke on activity and directions of auroral research in the US. Williams noted that the global view of the aurora, which had a pronounced emphasis at the conference, had only become possible in the last decade or so and that much effort today is devoted to integration of local measurements and interpretations of them into the developing global perspective. Future progress will similarly depend on the integration of local and global measurements, the latter being not only of the aurora but of the magnetosphere as a whole. Much of the high altitude magnetosphere couples or maps rather directly to the auroral ovals, so global magnetospheric imaging would be important to auroral research.

In support of the global approach, Williams cited the US role in the International Solar Terrestrial Program (ISTP) that is underway, the comprehensive ground-based complement of measurements (including optical, magnetometer, and radar), the new large-scale riometer device recently introduced by T. Rosenberg (University of Maryland), and the backscatter radar developments described by APL's R. Greenwald.

In greater detail, he described the new imaging technique utilizing energetic neutral atoms that provide a global view of magnetospheric plasma domains. The possibility or desirability of a Scout-launched explorer dedicated to neutral and optical global imaging was mentioned and discussed on several occasions at the conference. The question period following the talk emphasized the importance of active experiments in future megnetospheric efforts, particularly with regard to auroral and ionospheric processes.

Russian Auroral Research Program

R. Sagdeev (IKI, Moscow, USSR) spoke on the Russian program and plans. Sagdeev pointed out that although the USSR has the largest area of any country under the auroral oval the Soviets have not made the best use of this natural potential. Plans and programs are rapidly developing to pursue ground-based studies more enthusiastically in the future. The space efforts planned are all multinational efforts. These include Interball, which is a two-spacecraft mission, Auroral Probe, with apogee at 104 km, and Geotail, with apogee at about 2×10^5 km.

Geotail will be launched first in 1990-91 followed in 2 months by Auroral Probe in order to achieve the greatest possible conjugacy between them. Interball can be considered to be a precursor to the future Cluster and ISTP programs. The spacecraft will be well equipped with an auroral imager and detectors to measure the plasma distribution, composition, energetic particles, waves, and magnetic and electric fields. Active control of the spacecraft electrical potential will be possible by means of a small electron beam. This will enable measurement of the important low-energy (thermal) particle population. An elaborate complementary set of ground-based observations is planned including auroral and magnetometer networks and the EISCAT radar system. About 10 nations are involved and will participate in workshops to coordinate and plan special research campaigns.

The principal extraterrestial activity will be the Phobos mission to Mars that involves two satellites (the second of which was successfully launched during the conference). Mission objectives are to make detailed observations of Mars and its satellite Phobos. The satellites' perigee at Mars will be about 1000 km and a rendezvous with Phobos will take place at very slow speeds (about 2 to 5 m/sec) allowing very close-up observations (about 30 m). Two magnetometer experiments are included in the mission, one by East Germany and one by Austria. Observations will be made on Mars' ionosphere and possible auroras. Two types of active experiments will be made on Phobos. Ion Beams will be used in conjunction with a mass spectrometer to probe the composition of the source, and a modest pulsed laser (1 ns, 1 Joule/pulse) will be used to vaporize and ionize material (about 10^{-8} gm) from a 1-mm spot. For the future, a Mars network is planned which includes a Mars rover, balloons, and orbiter.

Western European Auroral Research Programs

B. Hultquist (Swedish Institute of Space Physics, Kiruna) described Western European programs and plans in auroral research for the next decade. Northern Europe has a long tradition in conducting auroral research, perhaps because of the relatively mild climate offered for such work, primarily in ground-based activities but with a growing emphasis on space observations. The overall program is modest compared to the US program, but Northern European programs tend to be more stable and dependable than the US programs. In the next decade, areas of emphasis will include: optical observations (both ground-based and from space) of the dayside aurora with improved spatial and temporal resolution; global and regional imaging; multipoint experiments, as with Cluster; and active experiments.

For practical reasons, ground-based auroral programs are concentrated in Northern Europe, particularly Scandinavia, and include optical, magnetic, and ionospheric stations and networks. The programs make use of all-sky cameras, TV systems, spectrophotometers, interferometers, magnetometers, ionosondes, and the latest riometers. Ground-based images of the aurora are of special importance since finer temporal and spatial resolution is obtained than can be gotten from space. Existing magnetometer networks will be increased, particularly in association with the EISCAT radar system. Unfortunately, Denmark is planning some cost-saving measures that will decrease coverage in the important magnetometer network they control in Greenland and islands in the North Atlantic. Norway, in collaboration with the USSR, will establish four new stations identically equipped to investigate the dayside aurora and cusp; the program will begin in 1989.

Radar research is extensive and includes EISCAT, STARE, SABRE, the Sondre Stromfjord collaboration with the US, particle reflection facilities, and the ionospheric heating facility at Tromso used for active experiments. The EISCAT facility is currently operated at UHF frequencies but should soon begin VHF operations, perhaps at full power sometime in 1989. The USSR is planning to add a radar antenna by 1990 that would render the VHF system bistatic and expand its capability. An important development will be the addition of a superheater that the West Germans will install at Tromso. The heater will deliver 3-4 times more power to the ionosphere than the present facility. Discussions are also taking place to establish a new incoherent radar facility to expand the EISCAT coverage further into the polar cap by the late 1990's.

The sounding rocket programs of Norway, Sweden, and Denmark are active and involve unique platforms. These programs will continue at the current launch rate.

Recent satellite programs have included VIKING and participation in other missions including Polar Bear of the US. For the immediate future, Europeans will participate in several missions: the Japanese mission EXOS-D (1989 launch); the Danes in the ACTIVNYI mission of the USSR (1989 launch); the Soviet mission Interball (launch 1990-91) particularly with the multipoint measurements and the auroral imager; POLAR of the US (1992 launch); and the US satellite TIROS.

Projects in the planning stages include a Swedish satellite, Freja (essentially a VIKING 2), scheduled for launch in 1991-92. This will be a small spacecraft, equipped similarly to VIKING but with a much greater data rate, a different orbit, and intended to study the lowest region of interaction between the ionosphere and magnetosphere. An imager will be on board. Measurements should have a high temporal resolution. The Europeans also plan to participate in the Scout-launched Imaging Explorer to be proposed to NASA by an American group (the neutral atom imaging technique described by Williams). The Imaging Explorer will have neutral particle and optical global imaging. IMPACT, planned for a 1993 launch, is a German-led mission outside of ESA with Soviet, Swedish, and other participation. Active experiments and measurements with temporal and spatial resolution increased by an order of magnitude are planned. Cluster, the joint ESA, NASA, USSR program planned for a 1995 launch and emphasizing multipoint measurements, will be an important mission for most European groups. Looking further ahead, the Space Station and Polar Orbiting Platforms will have European cooperation. The latter will include AURIO, planned for launch in the late 1990's, and will emphasize optical and x-ray experiments.

Japanese Auroral Research

The Japanese space research program was described briefly by A. Nishida (ISAS, Tokyo). The Japanese program consists of space missions, rocket campaigns, ground-based campaigns, and a program of supportive data analysis and theory. Space missions include EXOS-D, in the final stages of preparation with a standard array of space instruments and scheduled for a 1989 launch; GEOTAIL, planned for a 1992 launch; and a magnetospheric imager which is in the study phase.

GEOTAIL would be launched by the US. The mission takes place in two phases, the first using a lunar swing-by to investigate the distant magnetotail out to about 220 earth radii and the second to probe the near magnetotail out to about 30 earth radii. The orbit will be chosen to maximize the time to search the magnetotail for neutral lines. The existence and location of neutral lines is a controversial subject used in interpretations of sub-

storm mechanisms and central to the process of magnetic reconnection. The magnetospheric imager mission is evidently a new initiative that would include the global neutral imaging approach described by Williams. Current plans are to utilize a sensitive, large aperture telescope to observe helium ions to obtain global magnetospheric images. Plans are to invite international participation in the mission.

8/1/88

SUPERCONDUCTIVITY

Critical Current Problems Addressed in the New High Temperature Superconductors

by Alan F. Clark. Dr. Clark is the Liaison Scientist for Superconducting Materials and Electromagnetics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until March 1989 from the National Bureau of Standards in Boulder, Colorado, where he is Group Leader of the Superconductor and Magnetic Measurements Group.

A major problem hindering the rapid application of the new high critical temperature (T_c) superconductors is their inability to carry adequate amounts of electrical current. This is manifest in their low critical current densities (J_c), especially at the magnetic field levels found in most applications. In a 1-day workshop on Critical Currents in High T_c Superconductors experts from Europe, the US, and Japan presented their latest results in tackling this problem and discussed potential methods for improving the current-carrying capabilities of the new oxide superconductors.

The meeting was held at the University of Birmingham, UK, on 16 May 1988 in conjunction with the Low Temperature Group of the British Institute of Physics (IOP); it was sponsored by the Office of Naval Research-London the IOP, and Butterworth Scientific, the publishers of *Cryogenics*. During the meeting six invited speakers from the US, Germany, France, and the UK presented reviews of various aspects of the critical current problem and led discussion of their subjects. The remainder of the day and early evening were used for the presentation of about 20 short papers, interspersed with wine and cheese and liberal amounts of lively discussion. The meeting was chaired by A.F. Clark, ONRL, D. Dew-Hughes, Oxford University, and A.D. Caplin, Imperial College, London. More than half of the papers will be published in a special issue of *Cryogenics* to appear in October 1988.

Invited Papers

In the first of the invited papers Dr. H. Kupfer, Kernforschungszentrum Karlsruhe, West Germany, reported on the measurement of intergrain and intragrain critical currents in bulk polycrystalline copper oxide superconductors. Using an inductive measurement technique he was able to separate the limiting currents between and within grains to analyze their behavior. From the magnetic field and temperature dependence of the weaker current between grains, he concludes a percolation current at the superconducting boundaries and points to the possibility of raising the values of J_c by optimizing at field values greater than 0.5 T. For the intragrain critical currents he observes the 3rd power dependence on the upper critical field, a peak corresponding to the peak in the pinning force, and a possible correlation with the twin spacing.

Dr. C.E. Gough, Birmingham University, UK, outlined the various possible temperature and field dependencies expected for different weak link possibilites and compared them to magnetization measurements on ring specimens which can be quite sensitive. A possible thermal activation mechanism suggested magnetization measurements as a function of time below and near the critical temperature. The magnitude of the decay was about right but the decay was slower nearer to T_c!

The relationship between microstructure and measurements of polycrystalline, oriented specimens of the oxide superconductors was then discussed by Dr. D.C. Larbalestier, University of Wisconsin, Madison. Using a DyBaCuO powder in solution, his group aligned the material in a magnetic field then slowly evaporated the solution and cold pressed the material to obtain dense, well-oriented specimens. Anisotropies in the critical current of more than an order of magnitude were observed and related to the microstructure found along the grain boundaries.

Detailed study of the resistive transitions in YBaCuO wires led Dr. J.E. Evetts, Cambridge University, UK, to some innovative techniques and interesting conclusions. The variation in voltage with magnetic field at a constant current in the transition region can be simply related to

the field dependence of the critical current. From studies of this, especially at low fields, he concluded that significant flux trapping takes place along the weak link boundaries as well as some flux compression. This leads to critical currents that are dependent on magnetic history and current criteria as well as the microstructure impurities, orientation, etc.

Dr. P. Dubots, Laboratoire de Marcoussis, France, compared the critical currents and ac susceptibility of powder-based wires made from Chevrel, A-15, and oxide superconductors. Measurements of PbMoS, NbAlGe, and YBaCuO in similar states showed some remarkable similarities, including the double transitions characteristic of weak link behavior. However, comparison with the local microstructure at the grain boundaries implied different solutions will be necessary to improve the critical currents in each case.

In the final invited talk Dr. G.B. Donaldson, University of Strathclyde, UK, considered the weak link problem as a network of Josephson junctions and analyzed some of the expected behavior. Measurements imply not only weak link behavior between grains, but also within. He concluded that inductances will be high and some of the penetrating flux is poorly pinned, creating problems for some applications.

Contributed Papers

In the great variety of contributed papers there were many interesting results ranging from measurements of the effect of processing, twinning, or high fields, to the development of contactless methods or new devices, to theoretical modeling of flux creep or critical currents in granular superconductors. Several conclusions were stated in these works. Some were: (1) twinning and grain size had little effect on critical current; (2) there is strong relaxation of the magnetization in BiCaSrCuO near T_c, indicating weak pinning; (3) flux creep may be a definite problem; (4) weak links were observed within grains, but twin boundaries are not weak links; (5) contacts can be a real problem, especially at high fields, but contactless methods are possible; and (6) critical currents can be a function of size, shape, criteria, and much more than sample processing and microstructure. There were several reports of critical current values in processed wires of 10's and 100's of amps/cm^2 which were encouraging, but real excitement was registered when R.G. Humphries of the Royal Signals and Radar Establishment, Great Malvern, UK, reported 5x10^5 amps/cm^2 at 64 K in an rf-sputtered and laser-etched polycrystalline YBaCuO film.

Discussion

These results all led to intensive and vigorous discussion about not only the problems in measuring, interpreting, and improving the critical currents in the new high T_c superconductors but also about understanding the fundamental mechanisms of current transport in these highly complex materials. It is only with this understanding that the objectives of higher current applications will be realized. The promising results, sophisticated analyses, and clever devices discussed at this first Critical Currents Workship generated an underlying optimism which the group carried away to pursue further developments.

7/10/88

Large Critical Current Densities Observed in Polycrystalline Thin Films of New High T_c Superconductor

by Alan F. Clark.

High values of the critical current density (J_c) for polycrystalline thin films were reported at a recent workshop, Critical Currents in High T_c Superconductors. At the workshop, held at the University of Birmingham in May 1988 Dr. R.G. Humphreys of the Royal Signals and Radar Establishment at Great Malvern, UK, described the preparation of $YBa_2CU_3O_7$ thin films on $SrTiO_3$ substrates and then reported their very good critical currents. The films were rf-magnetron sputtered from metallic targets in an argon-oxygen atmosphere and then annealed in oxygen to yield epitaxial grains of about 1 μm. The films were then laser scribed with the 2-μm spot of an argon ion laser for four-terminal transport current measurements.

Critical current densities of greater than 5x10^5 amps/cm^2 were measured at 77 K for several of the films. At 30 K typical J_c's were 4x10^6 amps/cm^2 and still rising. At a magnetic field of 2 tesla these values were reduced by about a factor of 6. These values of the critical current density are nearly those reported for single-crystal and oriented polycrystal films and may well indicate that these will not be necessary for device applications.

7/11/88

NEWS, NOTES AND ABSTRACTS

New Venue for Rapid Publication of Scientific Results

A new opportunity for rapid dissemination of fresh scientific results is presented by the new publication policy of *les Compts Rendus of the French Academy of Sciences*. The new policy introduces English to the publications, and provides for publication within 5 weeks of short notes/articles in either French with an abstract and an abridged version in English; or in English with an abridged version in French. Notes have a maximum length of four pages (text and figures) plus one to two pages for the abridged version. Notes must be submitted via a Member of the Academy or a Correspondent. A list of their names may be obtained from: Le Service des Comptes rendus de l'Académie des sciences, 23, quai de Conti, 75006 Paris.

James E. Andrews
9/15/88

The Research Institute of the Deutsche Bundespost

Traditionally, the telephonic and telegraphic communications in most Central-European countries were handled by the governmental postal services. For this reason, it was only natural that most national post offices organized systematic in-house research activities in these areas which, in more recent times, have become high-level research institutes in all modern aspects of telecommunication. In my opinion, the best of these on the European continent is the research institute (FI, for Forschungsinstitut) of the West German Federal Postal Services (Bundespost). This establishment has a long and respectable history. Its origin can be traced back to the 1920's, and from 1937 to 1945 research has been concentrated in a branch of the Central German Post Office in Berlin.

In 1947, the British Occupation Forces found it expedient to revive the research groups, and after a number of structural changes the FI, housed in a modern skyscraper at Darmstadt, now operates as an independent unit of the administrative entity called Telecommunications Central Office (FTZ, for Fernmeldetechnisches Zentralamt.) The FI is headed by a scientific director, who operates through a research council and is monitored by a supervisory board. (The latter also acts as an advisory board for the FTZ management.) The FI has 350 employees (some 60 of them are not in Darmstadt but in a West Berlin branch office.) Out of these, 130 have a higher university degree. The FI also has strong working ties with many West German (and even some foreign) universities – in fact, about 10 M.S. theses per year (and occasionally a Ph.D. thesis) arise from this partnership. In addition, the FI participates in a large number of European international projects (including EUREKA and RACE). Not counting salaries, the annual research-expenditures have now reached the level of DM30 million (about $18 million).

FI's research is organized into five areas:

- A1. Information processing
- A2. Transmission technology (in material media)
- A3. Antennae and wave propagation
- A4. Solid-state electronics
- A5. Switching and networks.

The breakdown of these broad areas into research-group projects is as follows:

- A1. Mathematics for communication technology, acoustics, cryptology, information processing of voice and video signals, information processing of speech transmission, high-resolution television, computer-aided network design.
- A2. Digital transmission methodology, channel quality in digital transmission, optical switching and optical networks, transmission technology through fiber-links.
- A3. Antennae, wave propagation for point-to-area radio services, wave propagation in ground-station/satellite links, wave propagation in directed high-frequency-range transmissions.
- A4. Semiconductor technologies, microelectronic circuits, optoelectronic components, optical devices for telecommunication, materials research and testing.
- A5. Digital networks, digital multiplexing methods, broadband switching, optimization of communications networks, consumer-premises networks.

I do not find it necessary to give details of current and planned research activities because, apart from brief leaflets, I also have an excellent, professional "Annual Report" of the FI, for the year 1987. (The report is in English, 54 printed pages, and has, in addition, a 32-page appendix listing papers published in 1987, personnel data, cooperative work, etc.) I suggest that interested parties establish direct contact with the Director (currently Dr. Udo Mlecek), Forschungsinstitut der Deutschen Bundespost, Postfach 5000, Am Kavalleriesand 3, D-61 Darmstadt, West Germany. Telephone: (011-49-6151) 831. I am sure that any contact could be beneficial.

Paul Roman

Huge German Cooperative Research Center for Artificial Intelligence Has Been Launched

On 4 July 1988, the carefully planned and vigorously pursued goal of a multifaceted, nationwide research center for predominantly basic research in artificial intelligence (AI) came into being with the official incorporation of the Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI), GmbH. This enterprise, DFKI, with the unusual structure of a "Ltd" or "Inc" institution, has its central administration and its excellent new laboratory building in Kaiserslauten. The executive director of the "company" is

Professor Barth. DFKI comprises segments of nine industrial firms (Siemens and Philips are the largest), two national labs for computer science, two universities (Kaiserslauten and Saarbrücken), and contributing representatives from the two "Länder" (States) of Rheinland-Pfalz and Saarland, as well delegates from the West German Federal Ministry of Research and Technology. The present staff includes about 100 scientists. The budget (for personnel costs alone!) is DM50 million (about $29 million), to be spent within the next 10 years. After that date, the DFKI may or may not be dissolved, or reoriented, if need be. (This fixed-term lifetime of new German research centers is quite typical, and serves to avoid "petrification" of institutions in the face of changing national goals or opportunities.)

In addition to this national (federal) AI center, the Freestate of Bavaria and the Land of Baden-Würtenberg are also setting up a joint center for AI. This will comprise several university departments and industrial labs.

Paul Roman

SINTEF–SCANDINAVIA'S LARGEST RESEARCH ORGANIZATION

The SINTEF Group is a Norwegian, nonprofit organization with a staff of just under 2000 specialists involved in all aspects of contract research. Founded in Trondheim in 1950 as The Foundation for Scientific and Industrial Research, SINTEF is the largest technological contract research organization in Scandinavia. The group is composed of four separate organizations which are constituted in different ways:

- SINTEF The Foundation for Scientific Industrial Research at the Norwegian Institute of Technology
- EFI The Norwegian Research Institute of Electricity Supply A/S (majority owner, SINTEF)
- IKU Continental Shelf and Petroleum Technology Research Institute A/S (wholly owned by SINTEF)
- MARINTEK Norwegian Marine Technology Research Institute A/S (majority owner, SINTEF)

Additionally, there are a number of affiliated institutes, such as the Norwegian Hydrotechnical Laboratory, whose personnel and facilities SINTEF may call into use on a project-by-project basis.

In 1987 SINTEF did about $132 million worth of business. Norwegian industry, business, and public administration were the most important groups of clients. About 90 percent of SINTEF's income comes from its project work. Although SINTEF itself is organized into more than 20 divisions ranging over the spectrum of science and technology, the areas of greatest emphasis are marine technology/fluid dynamics, petroleum technology/geoscience, and information technology.

The SINTEF Group and The Norwegian Institute of Technology (NTH), collocated in Trondheim, work together in a close, integrated cooperative effort. This primarily means the common use of laboratories, equipment, and specialist staff. Research scientists from NTH participate in research projects in the SINTEF Group, while SINTEF Group staff often lecture at NTH. This association provides mutual benefits in that it makes a significant contribution to the overall level of competence in the SINTEF Group, while simultaneously helping to ensure that teaching at NTH is directed towards pertinent social requirements.

The multidisciplinary nature of SINTEF makes it an ideal organization for involvement in arctic research activities. The group offers extensive experience in an number of disciplines relevant to polar technology, including geotechnical engineering, rock and mineral engineering, oceanography, and environment protection. Support facilities include a 50x80x10-m ocean laboratory, an ice testing laboratory, cold rooms, a field laboratory on Svalbard, and a well-equipped portable laboratory container.

John P. Simpson
8/23/88

A New Neural Research Network

In addition to its already functioning scientific cooperation networks (see ESNIB 88-03:70 [1988]), the European Science Foundation (1 Quai Lezay-Marnesia, F-67000 Strasbourg, France) recently launched a new network of interdisciplinary nature. The purpose of this enterprise is the furthering of research in learning and memory. The aim is to bring together key individuals and labs working on the experimental analysis of the neural mechanisms of the memory processes. This could ultimately feed into work on neural computing. Another goal is to attempt an understanding between experimentalists and model-builders.

A brochure and further information may be obtained directly from Professor S. Rose, Director, Brain Research Group, the Open University, Milton Keynes, MK7 6AA, United Kingdom.

Paul Roman

Research Indicates Vitamin E Prolongs Life in Lab Animals

According to a news release from Haifa, attempts to slow the aging process in humans are likely to begin within 10 years, according to scientists at the Technion-Israel Institute of Technology. They have already succeeded in retarding aging in simple round worms by introducing the chemical substance, Vitamin E.

Moreover, research at the Technion has indicated that Vitamin E is most effective in retarding aging when introduced during the early stages of the worm's growth and development.

"The results suggest that something critical in relation to the aging process happens very early in life," said Professor David Gershon, a specialist in the molecular and cellular aspects of aging, and Chairman of the Technion's Biology Department. "If we are going to intervene in the human aging process, we will probably have to do so early on.... Our research is

helping us pinpoint oxidation as one of the major underlying mechanisms of aging in both animals and humans."

By introducing the antioxidant, Vitamin E, Gershon and his colleagues succeeded in reducing cell damage and increasing the life span of nematode worms. He and his team at the Technion determined when the antioxidant is most effective by introducing and withdrawing Vitamin E at different stages in the worms' life cycle. Gershon said that the antioxidant proved most effective when it was introduced at early stages in the worms' growth and development, and that the effects of the antioxidant were only marginal when introduced at a later stage.

This research on oxidation ties in with Gershon's previous innovative work on proteins. In the 1970's, it was thought that errors in protein synthesis were partially responsible for aging. If an amino acid is inserted in the wrong place as the protein molecule is being formed, the protein changes and a perpetual error is introduced.

While some altered or faulty protein molecules appear in the cells of young people, considerably more accumulate in the cells of the older person, Gershon said. His research, along with Professor Harriet Gershon, Chief of the Immunology section at the Technion's Faculty of Medicine, and their colleagues, indicates that damage to the protein coating of some cells, sustained in the ordinary course of living, is to a great extent due to oxygen damage.

"The disposal system for faulty proteins is more rapid and efficient in the young person than in someone older. It is becoming clear to us", Gershon said, "that the damage body cells substain is due to oxidation, an underlying mechanism of aging, which also damages the disposal system. Paradoxically, the oxygen we depend on for life is a source of our age-associated decline in function."

He believes that within the next 10 years, intensive research on oxidation as the source of cell damage will shed light on ways to intervene and retard the human aging process.

C.J. Fox
8/22/88

Siemens Reaffirms Its Commitment to Basic Research

In a recent statement, Dr. Claus Weyrich, the head of the Siemens AG research laboratories (West Germany) revealed that the basic development plan of Siemens for the 1990's is for it to become a world-leader in electronics and all aspects of electrical engineering; and hence, it is imperative that the research and development effort, aimed especially toward the mastery of emerging key-technologies (such as microelectronics, information sciences, modern manufacturing technologies, and materials) be further intensified.

Particular areas of planned development are office automation, integration of communication networks, automation of factories, energy supplies, and medical technology. Correspondingly, the Siemens Central Division of Research and Technology is organized into three branches: software technologies, automation (robotics), and applied basic research. The goal of the whole division is the pursuing of fundamental knowledge (rather than the development of products.) Laboratories of the division are located in Munich (the huge central research laboratories in the suburb Neuperlach), at Erlangen, and in West Berlin. There is also valuable cooperative basic research done in the Siemens-center located in Princeton, New Jersey.

The applied basic research effort encompasses the whole range from design of fundamental components to entire systems. Typical examples of research are ultrafast transistors (on Si or GaAs), transmission systems, ultrasound technologies for diagnosis, microanalytic instrumentation, and novel uses of synthetic materials.

In order to gain a good perspective on the Siemens research effort, the following data may be of interest.

Currently Siemens spends over DM 6 billion (about $3.4 billion) per annum on R&D. Out of this fabulous sum, more that DM 0.9 billion (i.e, about $540 million) is used for covering research expenses of the Central Division of Research and Technology. The division employs about 3000 people, of whom more than 1000 are actively engaged in basic research.

Despite these promising figures and future plans, I observed a certain unease in the ranks of researcher , because they perceive uncertainties regarding the organizational structure. A decentralization of basic research and shifts to more concrete (even though not product-oriented) research structures is anticipated by some.

Whatever the details may be of anv possible structural changes, the Sie- :as basic research effort is truly amazing and its reaffirmation is bound to produce results worth watching closely.

Further information on the Siemens research program may be obtained directly from Dr. H. Runge, Director of Information Services, Siemens AG, Postfach 103, D-8 München 1, West Germany. Telephone: (001-49-89) 2340. Reference to this news item would be appreciated.

Paul Roman

Very Powerful Excimer Lasers Introduced by Lambda Physik

Lambda Physik, a leading West German laser-development firm, announced the availability of the two latest, exceedingly powerful members of its well-known LPX excimer laser series. LPX 325i is now offered with the preliminary specification of 160-W output for KrF and 120 W for XeCl. (In the laboratory, even 220 W has been reached, and later specimens will probably have this output as a specification value.) For low repetition rates (up to 9 Hz) the maximum pulse energy exceeds 800 mJ. However, rather high repetition rates (up to 250 Hz) can be also achieved, in which case the discharge voltage is decreased, and pulse energies of at least 640 mJ are still guaranteed.

A more modest version, LPX 315i, has 95 W output for KrF and 70 for XeCl. The maximum repetition rate is 150 Hz.

In addition to these commercially available products, Lambda Physik also anounced further breakthroughs in experimental developn ent activities. Supported by the Federal Ministry of Research and Technology a team built an experimental XeCl device which, with a 310-Hz repetition rate, emitted a 4x5-cm beam of nearly 500-W power. The same setup will be also used for applied research

within the EUREKA EU-205 project aiming at a multikilowatt excimer laser.

For further information please contact directly Dr. U. Brinkmann, Lambda Physik GmbH, Hans-Böckler-Str. 12, D-34 Göttingen, West Germany. Telephone: (011-49-551) 69380.

Paul Roman

Council of Ministers Agree on European Fusion Program and Extension of JET Program

The European Fusion Program for the period 1988 to 1992 was adopted in July by the European Council of General Affairs.

Ministers also decided during the same meeting on a modification of the Statutes of the JET Joint Undertaking to extend the project by about two and a half years – up to the end of 1992.

Fusion has the potential to make an essential contribution to the energy independence of Europe in the next century. JET, the largest Community research project, has so far demonstrated the best results worldwide in the field of fusion. With JET and the specialized devices in construction or in operation in the associated laboratories – such as Tore Supra in France, ASDEX-Upgrade and Wendelstein 7-AS in Germany, RFX and FTU in Italy, COMPASS in the UK, and TCV in Switzerland – Europe is firmly establishing the ground for the next step. The resulting engineering test reactor, which is called the Next European Torus (NET), is at present in the conceptual design phase.

C.J. Fox
9/22/88

A Forthcoming Topical Conference on Glasses for Optoelectronics

The International Conference on Optical Science and Engineering (ECO), scheduled for 24-28 April 1989 in Paris, France, will accommodate a special topical meeting on glasses for optoelectronics. The purpose of this meeting is to discuss the status and the perspective of the following areas:

- Structure and properties of glasses
- Processing of glasses
- Applications of glasses in optics and optoelectronics.

Papers are now solicited in these and related areas. Further information may be obtained from the topical conference's chairman, Professor G.C. Righini, IROE-CNR, Via Panchiatici 64, I-50127 Firenze, Italy.

Paul Roman

ONRL REPORTS AND MAS BULLETINS

Reports

To request reports, indicate the report number (in parentheses after the title and author's name) on the self-addressed mailer and return it to ONR, London.

Computer Science

European Seminar on Neural Computing, by Claire E. Zomzely-Neurath. **(8-010-C)** The presentations given at this seminar, held in February 1988 in London, UK, are reviewed in depth. Topics range from neural systems and models through languages and architectures to the respective European and American perspectives on neurocomputing.

EUREKA Program Update, by Dr. J.F. Blackburn. **(8-009-R)** The EUREKA Program is brought up to date in this list, with descriptions of the 165 EUREKA projects. Also identified are the participating/interested countries, the cost, duration, and status. The topics under which these projects fall are: information technology; robots, manufacturing, and process control; biotechnology; new materials; environment; telecommuncations; transportation; energy; and lasers.

The RACE Program of the European Communities, by Dr. J.F. Blackburn. **(8-014-R)** The background of RACC – the program for R&D in advanced communications technologies for Europe – and progress in the technologies it embraces – are discussed. Those technogies include: switching, transmission, customer access, terminal and display, and coding.

Fluid Mechanics

Research in Fluid Mechanics, Control Theory and Such in Yugoslavia, by Dr. Daniel J. Collins. **(8-013-R)** The author visited Yugoslavia's Universities of Belgrade and Sarajevo, the Institute for Control and Computer Sciences of the Energoninvest company, and two research institutes – Steffan Institute and Rudger Boskovic Institute. He reports on the control theory, fluid mechanics, and other research being done there.

Materials Sciences

Sixth International Conference on Composite Materials (ICCM-VI), by Drs. S.G. Fishman and Y.D. Rajapakse. **(8-015-C)** Selected papers presented in five of the six sessions held at this meeting in London, UK, are discussed. The areas covered in the sessions these papers were given are: metal matrix composites, ceramic matrix composites, mechanical characterization, impact, and nondestructive testing.

Engineering Materials for Very High Temperatures – an ONRL Workshop, by Dr. Louis Cartz. **(8-016-R)** The limitations of present-day materials at very high temperatures are reviewed; silicon nitride based ceramics, silicon carbide, and carb-

on-materials. Near-term and long-term studies are described to improve the performance at temperatures above 1400°C of monolithic ceramics, composites, and ceramic coatings. The full texts of the papers given at the workshop are included.

Physics

The XII European Conference on Few-Body Physics, by Dr. Michael I. Haftel. **(8-012-C)** The contributions to this conference, held at Fontevraud, France, are discussed under three general categories: the nuclear force problem, including the possible effects of quark structure; properties of few-nuclear systems, especially as probes of the nuclear force; and atomic and molecular few-body problems and calculational methods.

Superconductivity

High-Temperature Superconductivity Research in Selected Laboratories in the Federal Republic of Germany, by Drs. Donald H. Liebenberg and Alan F. Clark. **(8-011-R)** The superconductivity work at eight West German laboratories is reviewed. The laboratories are (or located at): the University of Giessen; the Technical University at Darmstadt; Hoechst AG; Siemens AG; KFA Julich; KFK, Karlsruhe; the Walter Meissner Institute, Garching; and the Max Plack Institute, Stuttgart.

MAS BULLETINS

The following Military Applications Summary (MAS) Bulletins were published by the ONR, London, during September. The MAS Bulletin is an account of accomplishments in European naval research, development, test, and evaluation. Request copies of the Bulletins, by number, from ONR, London.

58-88 European Transonic Windtunnel

59-88 Fiber Optic Sensors for Underwater Applications

60-88 RAMBS – Rapid Anti-Personnel Minefield Breaching System

61-88 SINTEF – Scandinavia's Largest Research Organization

62-88 A German Achievement in the Area of Mid-Infrared Diode Lasers

63-88 Air Defense Alerting Device (ADAD)

64-88 The Hawk Owl FLIR System

REPORTS ON EUROPEAN SCIENCE AND TECHNOLOGY FROM OTHER COMMANDS

Reports

Information on each of the reports listed below was furnished by the activity identified by the abbreviations for that office. Report numbers are given in brackets after the titles. Requests for copies of or information about the reports should be addressed to the appropriate office:

USARDSG – US Army Research Development and Standardization Group, Box 15/65, FPO New York, 09510-1500

EOARD – European Office of Aerospace Research and Development, Box 14, FPO, New York 09510

Behavioral Sciences

Optimizing the Response of Head-Coupled Systems to Dynamic Head Movements, by the Human Factors Research Group, Institute of Sound and Vibration Research, University of Southampton, a report of research sponsored by the Armstrong Aerospace Medical Research Laboratory (AAMRL) and monitored by USARDSG [Available through the Defense Technical Information Center (DTIC)]

This report presents the findings of a research program concerned with optimizing the response of head-coupled systems to dynamic head movements. Previous research has indicated that a lag of 80 ms duration in the system will significantly degrade the operator's ability to track a moving target. In addition, lag compensation by deflecting the image back to its pre-lag position provided satisfactory improvement in task performance. However, this deflection technique imposed a restriction to the field of view of the display. The research reported here involved determining the likely extent of the problem and testing solutions by predicting head position. Also, preliminary data from a fundamental study of stationary target aiming by the head and the finger are reported.

Experimental results show that tracking performance was significantly degraded by a lag of magnitude greater than or equal to 40 ms, where the average percentage time on target dropped from 10 percent at zero lag to 14.5 percent with a 40-ms lag. Measurement of mean radial error, subjective difficulty rating, and percentage time on target confirmed the previous finding that the deflection used to compensate for lags improved the tracking significantly.

The degree of deflection needed to compensate for lags was found to be decreased when using a prediction of head position. (With 100- ms lag, the degree of deflection dropped from 1.72 to 0.69 in the pitch axis). This finding is of great value since it helps to overcome the restriction on the field of view arising when the deflection needed exceeded half of the helmet-mounted display's viewing angle.

In vibrating environments, the ability to aim at a stationary target with the finger and head have been compared during exposure to vertical motion for 0 to 10 Hz. Below 3 Hz, the measured seat to finger transmissibility is larger than the projected head transmissibility (rotational motion of the head projected to the finger position to form translational motion). Above 3 Hz the situation is reversed. At 1 Hz, the measured seat to finger z-axis transmissibility was approximately 2 while the projected transmissibility from the head is 0.5; at 3.3 Hz, the projected head transmissibility reached the peak of 4.5 while the measure of finger transmissibility was only 1.5

Chemistry

Ionization Processes Related to Contamination, by Bates, EOARD. (12 pp) [EOARD-AFOSR-85-0202]

Calculations have been carried out on the photoionization of OII ($^4S°$, $^2D°$ and $^2P°$) and on the photoionization of NI ($^4S°$, $^2D°$, and $^2P°$). An explanation has been advanced for the enhanced abundance of heavy ozone in the stratosphere. A published proposal for resolving the apparent ozone deficiency in the region above the 95-km level has been examined and shown to be unsatisfactory. A method has been devised whereby the low-density limit to the rate coefficient for thermolecular association of ions and polar molecules may be found from measurements on the rate coefficient even outside the region where third-order kinetics prevail. The theory of radioactive association when the stabilization is brought about by an electronic transition has been developed.

European Battery Chemists Visit the Army Electronics Technology and Devices Laboratory (ETDL), by Dr. F.J. Campbell, USARDSG. [Address inquiries to Dr. Campbell.]

In cooperation with Dr. Mark Solomon in the Power Sources Division, visits by ETDL by two investigators in the area of battery technology were sponsored by USARDSG (UK) Research Division: Professor Keld West from the Institute of Physical Chemistry at the Technical University of Denmark in Lyngby, and Dr. Alan Hooper from the Harwell Laboratory in the UK. Professor West's visit was arranged as a combination of a visit to ETDL and participation in the 33rd International Power Sources Symposium in Cherry Hill, NJ. At both occasions he held discussions with Army scientists concerning cathode materials for rechargeable lithium batteries, solid-state electromechanical measurement techniques, and the use of polymer electrolytes in place of liquid electrolytes. While there, he also gave a plenary lecture entitled "Intercalation Materials: EMF and kinetic properties related to structure and chemistry." Dr. Hooper's visit included his presentation of a seminar describing work at the Harwell Laboratory on solid-state batteries. This was followed by individual research discussions with several staff of the Battery Research Group. A number of overlapping technical interests were identified and there may be some scope for mutual improvements in device performance via cross-system technology transfer with regard to such issues as carbon properties and capacity decline. Harwell may be able to offer some novel approaches to the development of high-rate systems through high-temperature flexible electrolyte fabrication.

International Symposium on Photochemistry, by Dr. R.J. Campbell, USARDSG. [Address inquiries to Dr. Campbell.]

Photochemistry is an extremely active and important area of chemistry, with far-ranging implications for current and potential use in a number of areas of interest to the Army. With partial support from the USARDSG-UK Research Division Chemistry Branch, an international symposium addressing research in this field was held in August in Bologna, Italy. This symposium was the twelfth in a unique and highly regarded series held under the auspices of the International Union of Pure and Applied Chemistry. The program included lectures and discussions on such topics as electron transfer photochemistry, photodissociation of molecules, studies of excited states of coordination compounds, photoisomerization, and photoprocesses in liquid crystals and photosynthetic reaction centers. The Army relevance of studies such as those reported at the meeting is broad, ranging from organic reaction mechanisms with important implications in the area of energetic materials and novel polymeric materials, to potential application in the area of photoimaging, photoresists and degradation of noxious substances.

Environmental Sciences

Improved Snow and Cloud Monitoring: New Climatological Relationships Between Surface and Satellite Observations, by A. Henderson-Sellers, K. McGuffie, and A.H. Goodman, Department of Geography, University of Liverpool, a final report on research for EOARD. (149 pp) [Available through the Defense Technical Information Center (DTIC).]

There is agreed and urgent requirements for adequately complete cloud information. It is now recognized that satellite data alone cannot satisfy this, partly because low-level cloud is often hidden from the down-looking satellite and also because information on cloudbase, which is vital for surface radioactive flux calculations, is not obtainable. Additionally there is a need to validate satellite-derived cloud climatologies. The cloud field retrieved by the USAF Nephanalysis for July 1983 is examined in the context of its potential database for comparison with ISCCP in relation to features unique to the archive such as the inclusion, where appropriate, of conventional observations. Comparison with the corresponding data from July 1979 shows interannual synoptic differences and reflects a change in the method of incorporating surface data. A direct comparison with ground-based observation illustrates the effect of conventional data on the archive over a range of timescales. Examination of the Nephanalysis over difficult areas such as polar and desert regions reveals some of the problems pertinent to most current cloud algorithms. The information flags in the RT Nephanalysis for January 1985 are found to offer valuable additional information but some are ambiguous, at least for this month. A new basis for the relationship between the (vertical) earthview of cloud amount and the (whole dome) skycover of cloud amount has been sought. Over 4500 all-sky camera photographs, representing a considerable range of seasonal and climatological conditions (including the Lund data and a new data set obtained during the First ISLSCP Field Experiment [FIFE] in Summer 1987), have been analyzed to give rise to a data base from which predictive relationships for earthview, E, and skycover, S, have been established. Cubic functions are the most soundly based, both physically and empirically. If earthview is required from skycover observations then E S could be used with little additional error. Hence, conventional surface observations of skycover could be compared directly with satellite-derived earthview values.

Moreover a preliminary exploration of 4 months of surface station reports (global coverage) as supplied by ETAC OL-A indicates that the application of the random overlap hypothesis to the analysis of real cloud fields is inappropriate. Here we examine the climatological contingency probabilities of co-occurence of clouds and establish that the assumption made by Julius London and his coworkers is invalid at most spatial scales. This conclusion means that their maps of the probability of there existing low-level clouds

hidden from the satellite view by a higher cloud overcast should be modified.

Materials Science

Atomic Surface Microscopy at the University of Basel, by LTC LaRell Smith, EOARD. (10 pp) [EOARD-LR-88-41]

The research group of Professor E. Guentherodt is one of the most active in Europe in the field of Scanning Tunneling and Atomic Force Microscopy (STM and AFM). Their efforts are wide ranging with numerous projects ranging from looking at the surface of metallic glasses to investigating the surface of Langmuir Blodgett films to using STM and AFM for investigating the new high-temperature superconducting materials. They have developed a method for using an STM to reversibly, physically modify material on a nanometer scale, which may lead to possible memory devices for electronics. This report describes their work more fully and includes excerpts from some of their recent publications.

Physics and Materials Research at the SOREQ Nuclear Research Center, by LTC LaRell Smith, EOARD. (20 pp) [EOARD-LR-88-43]

A recent visit of SOREQ uncovered several projects of interest to the Air Force. (1) Space Simulation: Dr. Geoffrey Lempert has submitted a major proposal to USAF for the development of a space simulation facility using SOREQ's MIERA facility to reproduce the highly energetic space environment (ions and neutrals). The facility is capable of fluxes of 10^{15} atoms/cc/sec with a possible 100 ma of N^+. (2) Fluoride/Chalcognide Glasses and IR Fibers: the SOREQ group has submitted a preproposal for laser damage measurements in fluoride glasses. In addition they are working on doped glasses for lasing hosts – particularly as fibers. Finally, Dr. A. Bornstein has developed a method of producing graded index material which could have significant impact on producing lenses. The method involves doping the glasses to produce a specific profile of refractive index. (3) Germanium for IR Applications: SOREQ claims to have the best Germanium crystals in the world for IR work. They are producing these commercially through their ISORAD division. They claim that even their largest diameter materials (20-30 cm) are single crystal and they provide an extensive specification set which the materials are guaranteed to meet.

Smith's report provides more detail on the above projects along with specific reprints, extracts, and the preproposals.

Thermal Barrier and Other Plasma Sprayed Ceramic Coatings, by LTC Jim Hansen, EOARD. (4 pp) [EOARD-LR-88-51]

Dr. I. Kvernes directs several Norwegian industrial efforts in plasma spraying ceramic coatings that act as thermal, corrosion, and wear-resistant coatings. A unique technique allows coatings to be plasma sprayed underwater, with considerable economic and technological benefit, e.g., low-oxide bond coats. Zirconia coatings are produced silica free, to increase fracture toughness, and with silicon carbide whiskers. Aluminum and magnesium are coated using patented bond coats of rapidly solidified powder to pass stringent thermal fatigue requirements.

Fracture Behavior Under Impact, by S. Winkler, USARDSG. (67 pp) [ARMY R&D 3012A-AN]

The behavior of cracks loaded by impact-generated stress pulses is investigated. A novel impact geometry is introduced for loading cracks under shear by pressure waves in combination with inertial forces. Interesting shear phenomena were found: adiabatic shear bands or dynamic shear cracks are generated at the crack tip. For their production, temperatures in the melting range must be generated by a very high lateral strain gradient. With specimens of a high-strength steel a steep increase of the tensile fracture toughness has been observed with times-to-fracture decreasing to about 5 s. The assumption of an incubation time is used to explain this behavior.

Modeling of the Impact Response of Fiber-Reinforced Composites, by S. Shuk, R.K.Y. Lik, and J Harching, Department of Engineering Science, University of Oxford, a final report on research monitored by EOARD. (pp not given) [Available through the Defense Technical Information Center (DTIC)]

An extensive literature survey describing previous work on techniques for modeling the mechanical response of fiber-reinforced plastics is presented. The proposed application of similar techniques in the present study is discussed and attempts to develop a finite element analysis of the stress system in the standard composite tensile specimen and in the loading bars of the tensile impact apparatus are described:

On the experimental side, modifications have been made to the traverse impact testing machine described in the Final Report on Grant No. AFOSR-85-0218, issued October 1987, allowing more accurate measurements to be made of the force, as well as of the displacement, during the impact loading process. These modifications are described and some of the results obtained are presented. A fuller report on this aspect of the work is now in preparation.

Testing techniques have also been developed for determining the compressive strengths, at both quasi-static and impact rates of straining, for woven-reinforced all-glass and all-carbon laminates loaded in both the warp and the weft directions. The results obtained have been used, in conjunction with the corresponding tensile strengths, determined previously, to predict the quasi-static tensile strengths of the three woven carbon/glass-reinforced hybrids for which experimental data are available, using the laminate theory approach described in the Final Report under Grant No. AFOSR-84-0092. An extension of this approach to the prediction of hybrid impact tensile strength has been developed and has been applied to one of the three hydrid laminates tested in the experimental program.

Review of MTL-Funded ERO Research Contracts, by Dr. W.C. Simmons, USARDSG. [Address inquiries to Dr. Simmons.]

In July 1988 Dr. Simmons reviewed the progress of ERO contracts at three sites which he visited whose financing was supplied by AMTL. Dr. Simmons was advised to review several of the AMTL-funded projects at the urging of SL scientists at AMTL: and in particular, to inspect the Elastomer Test Machine (ETM) developed at the University College of North Wales. Dr. A. Campbell at the Engineering Department of Cambridge University discussed recent progress under the ERO/MTL contract on superconducting oxides (5909-MS-01). The focus of the present program is on polycrystalline bulk ceramics as opposed to vapor-deposited single-crystal films,

useful in electronic applications. In order to obtain useful high current densities in polycrystalline materials, the Cambridge group is investigating the relationship and mechanisms of grain boundary conductivity, and the necessity for oriented, highly textured grains and high purity.

A second stop at Cambridge University, at the Cavendish Laboratories, was arranged with Russell Hand (works with Dr. John Field) to get a "Cooks Tour" of the impact and erosion facilities used in the ERO/MTL work (5087-MS-01). They also have a renewal proposal which was briefly discussed. In addition to the single-liquid-drop and single-solid-impact studies, there are special facilities for controlled multiple impact and sand erosion studies. Unique diagnostic facilities inspected including millisecond framing-rate cameras and a uniquely designed laser speckle interferometer which can measure transverse strains with high precision – also at microsecond framing rates.

Dr. Simmons and Dr. Hynes next visited the National Center of Tribology Risley Nuclear Power Development Laboratories, Warrinton, UK, to inspect the facilities and learn of the progress on the ERO/MTL/SDI research program (5876-MS-01), Advanced Tribological Coatings for High Specific Strength Alloys. Ultra-low-friction sputtered coatings of MoS_2 and selected treatments on Ti and Ti-Al alloys will undergo pin/disc rolling contact fatigue and bend fatigue tests. The tests are for gears as well as for bearings. Finally, at the University College North Wales at Bangor, Wales, UK, they viewed the Elastomer Test Machine, ETM, which was developed with funds provided by Dr. Shuford, AMTL, and now is to be modified and automated by a follow-on contract. A live demonstration of the various testing actions of the ETM was presented.

Final Report on New Cement Materials, by Dr. Wilbur Simmons, USARDSG. [Address inquiries to Dr. Simmons.]

Professor P.L. Pratt, Imperial College, London, points out in his final report (5130-MS-09) on New Cement Materials that significant technological developments open up new areas of utilization for high-density cementeous "composites." Two new cement materials, ICI's NIMS and Aalborg's Sensit, are compared to ordinary Portland cement, and future direction were suggested. Military applications in blast-resistant structures, launch pads, landing strips, bridges, marine application and container fabrication are discussed, with advantages and disadvantages.

Characterization of Lubricants in Terms of Transition Diagram Data, by J.W.M. Mens and A.W.J. de Gee, TNO Metals Research Institute, the Netherlands, USARDSG. (55 pp) [ARMY R&D 4481-AN-01]

Characterization of lubricants, meant for application in counterformal contact situations (concentrated sliding contacts), is usually performed with standard tests, e.g., of the four-ball type. Results, thus produced, are of limited value because of doubts regarding correlation with practical performance data. In this respect the IRG Transition Diagram method, developed by the cooperative efforts of eight different laboratories, probably stands a better chance of success. As an example, five high-performance lubricants – three mineral oils (Amoco 300, Citgo C-5, and REO 203) and two synthetic oils (Mobil Jet II and Royco 555) were characterized with this method.

Mathematics

Adaptive Phase-Only Algorithms for Optimal Planar Antenna Arrays, by J.C. Mason and Anne E. Daman, the Royal Military College of Science, Cranfield Institute of Technology, a final report on research monitored by EOARD. (73 pp) [EOARD-TR-88-10]

The positioning of nulls in an antenna array field pattern is essential to the performance of the antenna, in being capable of blocking interference. The null placement must be achieved in such a way that the field pattern in other directions is not adversely affected.

One of the most efficient methods of null placement is by perturbing only the phases of the array elements. Here, we present two approaches to the placement of nulls by phase perturbation. The first is a least squares method based on exact or approximate null placement, applicable to one-dimensional arrays and extendable to two-dimensional arrays, developed for real quiescent patterns which apparently allows polygonal arrays (in this study, octagonal arrays) to be considered. The second is a minimax method in one or two dimensions based on null placement, which readily permits the omission of failed elements and which involves only the perturbation of selected element phases or amplitudes.

We believe that these two approaches can provide between them a versatile choice. The least squares method is extremely efficient, the number of parameters being simply the number of null constraints, but all antenna weights need to be perturbed. The minimax method is much more expensive, since all antenna weights are parameters, but often only a small number of weights need to be changed. Both approaches are fairly robust. The least squares approach apparently permits polygonal arrays to be adopted, and probably more general geometries and configurations of failed elements might be adopted. The minimax approach is based on a very general optimization algorithm and therefore in principle permits rather wide-ranging specifications of constraints to be imposed by the user.

Both approaches are still under development; the theory is incomplete and algorithms have not been fully tested.

The Inverse Solution of Some Partial Differential Equations, by LTC Bob Winn, EOARD. (2 pp) [EOARD-LR-88-45]

Professor Francesco Zirilli is one of about 35 professors in the Department of Mathematics at the University of Rome, the home of Lagrange and other great mathematicians. Professor Zirilli has developed a unique method for solving inverse partial differential equations. Zirilli has used his method to solve problems which have previously only been solved with extensive computational effort. Zirilli now plans to apply his method to the wave equation which, if successful, would significantly reduce the computations required for such things as artificial vision and radar identification of objects. This report describes Professor Zirilli's method.

Meteorology

Greenland 1987, Rocket Chemical Releases: Barium Jets, February 26 and March 5 Barium, Neodymium, and Samarium Clouds, March 21, by Dr. I.B. Steen Mickkelsen, Division of Geophysics, Danish Meteorological Institute, a report on research monitored by EOARD. (pp not given) [Available through the

Defense Technical Information Center (DTIC)]

On February 26, 1987 the debris from three barium shaped charges, released in the polar cap, drifted in the antisunward direction during a minor expansion of the auroral oval. On March 5, 1987, the debris from three barium shaped charges, released in the dawn auroral oval, drifted antisunward in the recovery phase of a substorm. On March 21, 1987, six barium clouds, released in the dawn auroral oval, drifted intermittently sunward, poleward, and antisunward in a pattern probably organized with respect to subvisual auroral arcs north of the visible arcs. A samarium cloud drifted with the thermospheric winds, but a small fraction may initially have been ionized. The electric fields from the barium drift and the incoherent scatter radar in Sondre Stromfjord, Greenland, are equal within the uncertainty.

Ionization Processes Relating to Contamination, by Sir David Bates, Queens University of Belfast, a report on research monitored by EOARD. (pp not given) [Available through the Defense Technical Information Center (DTIC)]

Calculations have been carried out on the photoionization of OII (^{4} S°, ^{2} D°, and ^{2} P°) and on the photoionization of NI (^{4} S°, ^{2} D°, and ^{2} P°). An explanation has been advanced for the enhanced abundance of heavy ozone in the stratosphere. A published proposal for resolving the apparent ozone deficiency in the region above the 95-km level has been examined and shown to be unsatisfactory. A method has been devised whereby the low-density limit to the rate coefficient for the thermolecular association of ions and polar molecules may be found from measurements on the rate coefficient even outside the region where third-order kinetics prevail. The theory of radioactive association when the stabilization is brought about by an electronic transition has been developed.

Microelectronics

Correlation of Atomic Roughness and Electronic Properties at the Si/SiO_2 -Interface, by M. Henzler, Institut für Festkorperphysik Universität Hannover, a report on research sponsored by the USARDSG. (pp not given) [Request information by title and author from USARDSG]

Professor M. Henzler at the University of Hanover, West Germany, has completed research sponsored by USARDSG-UK on the correlation of atomic roughness and electronic properties at Si/SiO_2 interfaces. This research was motivated by the steady increase of large-scale integration which requires smaller and smaller structures with thinner and thinner layers. Simultaneously, the number of material defects also needs to be decreased making defect analysis very important for improvement of the production of devices. One key issue is the quality of the Si/SiO_2 interface. Professor Henzler's results have demonstrated that defects at the interface can be identified and quantitatively measured by spot profile analysis of low-energy electron diffraction (LEED). Whereas TEM and XPS provide some qualitative and limited quantitative results, only LEED was able to measure systematic variations of atomic roughness at the interface due to variation of oxidation parameters. A direct correlation of atomic roughness to electronic properties like mobility and interface state density was shown. A further result consisted of identifying, for the first time, regular step array at the Si/SiO_2 interface close to the (111) orientation. The procedures have been checked to find the best regularity. This discovery opens the possibility to probe a new transistor Bloch oscillator type by making use of the minigaps due to the step array periodicity.

Physics

Optical Properties of Inorganic Solid Materials, by Dr. Stacey Lazdinis, EOARD. (5 pp) [EOARD-LR-88-39]

The Department of Physics at the University College Galway is performing studies in properties of inorganic solid materials. The investigations of Professor George Imbusch and his colleagues, using optical spectroscopic, and both resonant and nonresonant fluorescence line narrowing (FLN) techniques, of materials having potential as active media in tunable solid-state lasers are described and summarized.

ASTERIX IV: The Most Powerful Iodine Laser in the World, by Dr. Stacey Lazdinis, EOARD. (7 pp) [EOARD-LR-88-50]

The performance of ASTERIX IV, the most powerful iodine laser in the world, is summarized. It is located in a newly constructed, ultramodern facility at the Max Planck Institut für Quantenoptik in Garching, West Germany. The laser radiates in the IR at 1.315 μm and is scheduled to achieve an output power of 5 TW/3 kJ during the coming year. Among its very impressive characteristics are its capability to generate subnanosecond pulses at multi-kilojoule energies with a nearly diffraction-limited beam. The device will be mainly used for laser-generated plasma studies.

Development of a Stretchable Concave Imaging Membrane Mirror of Variable Focus, by Dr. P. Waddell, University of Strathclyde, Scotland. (33 pp) [EOARD-TR-88-08]

The report describes the evolution of a plastic membrane, variable focus, concave imaging mirror, and a "zoom" mirror. A partial vacuum behind the membrane is used to create a uniform pressure difference across the membrane and force it back into a concave shape. Range of curvatures (obtainable) is from the flat to F/0.5, the classical limit for imaging in concave mirrors. Plastic membranes have been metalized with surface roughness down to 10 angstroms, as good as any mirror polished to date. The mirrors have been used with gas lasers to create very-large-sized holograms and white light holograms.

Physics and Applications of Quantum Wells and Superlattices, a book of lectures delivered at a NATO meeting supported in part by the USARDSG, edited by E.E. Mindy, IBM Yorktown, and K. von Klitzing, Max Planck Institute for Solid State Research, Stuttgart, West Germany. (pp not given) [Direct inquiries to Dr. John Zavada, USARDSG]

This book contains the lectures delivered at the NATO Advanced Study Institute on "Physics and Applications of Quantum Wells and Superlattices", held in Erice, Italy, on April 21-May 1, 1987. This course was the fourth one of the International School of Solid-State Device Research, which is under the auspices of the Ettore Majorana Center for Scientific Culture.

The purpose of this Institute has been to address in an integrated form the basic physical concepts of semiconductor wells and superlattices, and their relation to technological applications based in these novel structures.

Radiation Effects in Insulator, Proceedings of the Fourth International Conference on Radiation Effects in Insulators – including the Workshop on Radiation Damage in Nuclear Waste Materials, edited by P. Thevenard, A. Perez, J. Davenas (Université Claude Bernard Lyon I Villeurbanne, France) and Hj. Matzke, European Institute for Transuranium Elements, JRC, Commission of the European Communities, Karlsruhe Establishment, West Germany. (pp not given) [Direct inquiries to Dr. John Zavada, USARDSG]

The fourth international conference in the series devoted to the interaction of radiation with insulating materials was held on the campus of the University Claude Bernard - Lyon I in Villeurbanne (France) from the 6th to the 10th July 1987. Coupled with the conference for the first time, was a specialized workshop on radiation damage in waste glasses and ceramics.

Although the main themes of the conference were selected by the organizers a process of "natural selection" lead to the following main sessions: Ceramics, Organics, Halides, Glasses, Nuclear Waste Materials, Mixing and Adhesion, Sputtering and Desorption, High Energy Effects, and Developing Trends. A total of approximately 140 papers (invited, oral and posters) were presented, of which 98 are published in this volume.

Semiconductors

National Microelectronics Center, by Dr. Eirug Davies, EOARD. (3 pp) [EOARD-LR-88-25]

Centro Nacional de Microelectronica was created in 1985 to provide Spain with an expertise in microelectronics. It will soon move into new facilities in Bellaterra that will house silicon technology and a design center. Work on compound semiconductors is to remain at its present location in Madrid.

THE EMBASSIES: TECHNOLOGY ROUNDUP

France

For further information of French items, contact Mr. Robert K. Carr, Office of the Science Counselor, American Embassy, Paris, APO New York 09777.

New R&D Policy of the Recently formed French Government. The recently formed French government headed by Prime Minister Rocard has defined the government's priorities. Research and education are amongst the highest. This appears clearly not only in Prime Minister Rocard's statement of intent, but more concretely in the budgetary measures that have already been implemented and in the choice of the ministers who will directly or indirectly be involved in R&D. In particular, research and technology have been recombined and elevated to a full-fledged ministry reporting only to the Prime Minister. Reforms are urgent if France is to enjoy a position of strength during the creation of a single European market.

One of the top priorities of Rocard's government is to boost research, and, more particularly, industrial research. Compared with the main industrialized countries, the contribution of French industry to the financing of research is the lowest. It represented 43 percent of the total R&D effort in 1984, while it was 46 percent in the UK, 50 percent in the US, 58 percent in West Germany, and 66 percent in Japan. According to Prime Minister Rocard, French industrial research still needs about FF20 billion (about $3.3 billion) to become competitive. Only then will France be able to get out of a situation where industrial research is concentrated around a limited number of programs such as aeronautics, electronics, nuclear energy, and space.

Not only is industrial research faced with specific problems, but also French research as a whole, in two main areas: budget and employment.

Concerning the budget Rocard stated that the R&D policy implemented in 1986 which curtailed budgets did not help resolve any of the problems that France is being confronted with in the R&D sector. Laboratories are not going bankrupt, but scientists would like the government to follow a stable long-term budgetary policy and give laboratories – particularly the small ones – the means to acquire equipment. To remedy this situation, research and technology minister Hubert Curien intends to submit a 2- and maybe 5-year R&D plan to the French parliament.

Employment is the second problem. The government will have to create new positions and also resolve the problem of aging. The large number of recruitments in the 60's has led to the aging of researchers (43 years of age on average in 1988) which created bottlenecks in career ladders and precludes the recruitment of new researchers. Positions in research establishments which are offered today to the most brilliant researchers are not competitive with offers in management. The problem is that there is only one position for four applicants. As a result, young researchers are becoming more and more open to offers from foreign laboratories. Finally, the number of engineers' administrative and technical staff (ITA's) is decreasing when laboratories are in need of the best technicians and engineers to run equipment that is becoming increasingly sophisticated. In the past months, only one out of two departing ITA's has been replaced. This policy affected both good and bad laboratories. These positions will be unfrozen by the new government. But at the same time Hubert Curien is asking research institutions to be careful in the distribution of these positions and not to take advantage of this measure to systematically replace positions.

According to Curien, the problem in France is that public research institutions conduct what he calls "micro-evaluations." Research institutions determine whether the performance of a researcher or a research unit is good. But there is not really any "macro-evaluation" which would help determine whether, for instance, French research in physiology, semiconductors, and life sciences is competitive. Curien

appears to have five priority sectors for the next decade:

- Structure and reactivity (superconductors, semiconductors, pharmacodynamics, biology)
- Mathematics
- Process (automations, chemical engineering, etc.)
- Knowledge of natural environment (astronomy, space, earth sciences, climate, geology)
- Social sciences (economics, sociology).

Education is another priority of the new government. FF1.2 billion (about $0.2 billion) in additional funding have already been allocated for education. Aside from this budgetary measure, it is not clear yet what the new government intends to do. New Minister for Education Jospin did not give any information on the 1989 budget or on any future program law on education. For the time being, he is reviewing the situation. Because there have been so many reforms and counter-reforms in the past few years, universities are unclear as to their mandate. This is the most urgent problem to resolve. But there are other issues pending, among which are university research, the training of professors and researchers, and the reform of university cycles and subjects. With respect to university research, the new government would like to establish more bridges between universities and public research institutions (CNRS, INSERM, INRA, etc.), have the private sector participate in the financing of training through research, and organize, every year at the regional level, scientific conferences on a specific subject, grouping professors and teachers.

Promising Discoveries in Myopathy Research. Following the heels of the American discovery of the gene responsible for myopathy, the French research team of A. Kahn and J.C. Kaplan (National Institute of Health and Medical Research) have identified the genetic messenger (ARN Messenger) which acts as the link between the relevant chromosome and the production of dystrophine. The discovery was made thanks to PCR, a revolutionary technique which has also facilitated research in other genetic diseases, hepatitis B, and AIDS. The French breakthrough may eventually permit scientists to perfect an efficient prenatal diagnostic test.

Report from CEA Study on Underground Storage on Nuclear Waste. The CEA has recently published a summary of the results of a study done, at the CEA's request, to develop technical criteria for a long-term, underground nuclear waste storage site. The study was chaired by Professor Jean Goguel, a well-known geologist.

Between June 1985 and May 1987 the group, composed of geologists and specialists in nuclear safety and radiological protection, met 48 times in plenary session and on 40 other occasions in various subcommittees. The principal interest of the group was the efficacy of certain geologic structures (salt, shale, granite, and clay) and to give the French government a prioritized list of technical considerations for the location of an underground laboratory which would serve as a test-bed for a full-scale storage site.

This laboratory will be different from the existing test sites which the French refer to as "first-generation" labs such as ASSE, STRIPA, MOL, or GRIMSEL. This "second-generation" site will be dedicated to qualifying an actual storage site; to demonstrating its technical feasibility, and to qualify the site under actual storage conditions.

The underground site envisioned by the National Agency for the Treatment of Nuclear Waste (ANDRA) served as the point of reference for the study. The ANDRA site calls for: (1) a common site but with separate repositories for alpha and high-activity waste; (2) storage in galleries several hundred meters deep for alphas and storage in vertical shafts for the high-activity waste. Vitrified waste would only be included after a 30-year cooling period. The ANDRA site is envisioned as having 250,000 cubic meters of storage for alphas and 13,000 cubic meters of storage for high-level waste. In total, the site would store 100,000 tons of waste.

The exploitation of the site will take several decades, during which time the waste will be put in place with extra precautions taken to prevent radiation escape.

The group concluded that site selection has two overwhelming considerations: safety during the period of excavation and use, and the long-term safety of the waste vis-a-vis water and migration of radionuclides. According to the report, the geology will play a great role in the confinement of the radiation.

The geology should serve as a barrier for at least 10,000 years. (This period was picked because in 10,000 years the radiation should be attenuated by a factor of 10,000). The first 10,000 years are critical and therefore, site selection should be based upon a demonstration of site security viz. radiation leakage. This demonstration should be based on a precise model used for calculating the effects of the radiation on the geology and the long-term efficacy of the geology as a barrier. Since long-lived radionuclides should be isolated for 100,000 years or longer, the storage site should be intrinsically stable for that period of time. Although it should not need surveillance for that period. The flow of water through the site was regarded as the next most serious concern. Effectively, says the CEA study, it is only the flow of water that poses the problem of introducing radioactivity into the biosphere. This occurs because water degrades the integrity of the storage site and carries radiation out of the site. With respect to water flow, therefore, there are two principal criteria: low permeability of the geology and low hydraulic gradient in the region.

The group concluded that site selection studies must examine sites in terms of permeability, faults and fractures (and their contribution to the flow of water), and water table location and stability.

The CEA report also discusses the effects of geochemistry on the storage site. The report concludes that the geochemical properties of the storage site will play an important role in the long-term safety because these properties govern the phenomenon associated with the flow of water and radionuclides into and out of the site as well as the effect the chemistry could have on the storage casks themselves.

The report concludes that existing theoretical knowledge in this field is sufficient for accurately predicting the geochemical conditions of any particular site and thereby predicting the impact of these conditions on its long-term efficacy. The study cautions however, that the "natural conditions" of any site can be altered both by the excavation process and by the presence of radioactive waste in the geology. The report warns about the problems posed by the thermal effect of the waste on the geology of the storage site. Initially the temperature will increase greatly and then cool. This phenomenon of heating and cooling will cause an expansion and then a contraction of the rock; resulting

in possible fracture. The heating and cooling can also stimulate the flow of water or the degradation in the mechanical or physical properties of certain rocks. All of these phenomena have been identified and should be studied for each site and taken into account in designing the site and the methods of storage. The bottom line of the CEA study is that for any site it should be demonstrated that the presence of the radioactive waste will only result in the increase, of some 10's of degrees, in the temperature of the rock near the surface. They conclude that this value is negligible when compared with fluctuations in temperatures caused by climatic conditions.

In conclusion, the group underlined that there will be no substitute for evaluation of an actual working site. Only that will allow a definitive evaluation of the efficacy of the geology, the site design, and storage techniques.

Overview of the National Center for Scientific Research (CNRS). The CNRS vaunts itself as the first French organization covering the entirety of scientific domains to be established for fundamental research. Created in 1939, and placed under the guidance of the French Ministry of Research, the CNRS is a public national establishment dedicated to scientific and technological research. It is endowed with financial autonomy and is civilian in character. The CNRS's missions are to:

- Evaluate and effect research whose goal is to advance scientific, as well as economic, social and cultural progress of the country
- Contribute to the application and the exploitation of research
- Develop scientific information while favoring the use of the French language
- Participate in the analysis of the interaction between national and international science and its prospects for evolution in view of national politics in this domain.

The CNRS employs over 25,800 people of whom about 10,500 are researchers and 15,300 are engineers, technicians, and administrative staff. This staff is divided into seven major areas of research: earth, oceans, atmosphere, and space; nuclear physics; anthropology; chemistry; life sciences; basic mathematics and physics; and engineering sciences.

The overall budget for the CNRS is FF9 billion (approximately $1.5 billion). Seventy percent of this sum is allocated to salaries and maintenance fees. The remaining 30 percent of this sum is applied to research. Ninety-nine percent of CNRS's budget comes from the French Ministry of Research. The remaining 1 percent represents funds generated by CNRS's own resources. All funds are allocated to the director general of the CNRS, who then distributes them among the respective scientific directors of the seven major areas of research. Funds are then further reapportioned to specific laboratories by the scientific directors. The NCRS conducts research in three main types of laboratories: CNRS laboratories, "associated laboratories," and "mixed laboratories."

Primarily, CNRS operates in their own laboratories where they own the equipment, pay the rent, maintenance, and other associated fees. "Associated laboratories comprise the second largest type of laboratories employed by the CNRS. These are laboratories owned by universities which are funded by the CNRS for specific projects. Although they are not staffed by CNRS personnel, CNRS reserves the right to appoint members of its staff to work in these laboratories, and usually does so. "Mixed laboratories" are laboratories shared by the CNRS and another organization (e.g., the National Institute for Health and Medical Research [INSERM], atomic energy commission or private industry).

Traditionally, the area experiencing the most activity after the CNRS's own laboratories has been the associated laboratories, which number around 1000. However, because of the emphasis that the Rocard government has begun to place on the government's support of research and development in French private industries, CNRS expects to see a rise in activity in the "mixed laboratories" in terms of increased government funding. In fact, said Madame Schweighofer, CNRS's Director for Budgetary Planning and Forecasting, although 1986 and 1987 saw a decrease in government funding of "mixed laboratories," she has already observed an increase in this area for 1988.

French Microcomputer Industry Receives a "Mise en Garde." According to *le Figaro,* France has recently spent FF156 million (approximately $26 million) on 13,120 microcomputers for the public school system. Ironically, despite the new Rocard government's push to support French industry, the government has purchased the majority of this equipment from foreign companies, giving the French microcomputer industry a reason for concern.

According to the Union of Public Purchase Groups (UGAP), their principal criteria for microcomputer selection was an assessment of maximum performance for minimum price as well as an evaluation of the array of compatible accessories. That the UGAP made their decision to purchase an overwhelmingly high percentage of non-French microcomputers despite the "computers for all" plan (instituted by the government in 1985 to favor the burgeoning French computer industry) underlines the current lack of competitiveness of the French microcomputer industry. In fact, the French microcomputer industry currently holds less than 5 percent of the European market.

In this particular instance, Victor (an American firm acquired by the Swedish firm Datatronic) garnered nearly on half of the government's orders with a contract worth FF72 million ($12 million) representing 5906 units. In addition, Victor has won another contract for next year involving 800 machines and FF17 million (approximately $2.8 million). Olivetti-Logabax (an Italian firm) will deliver 2371 microcomputers. The 5056 printers ordered will be furnished by the Japanese firms NEC and Epson, and 696 digitalizers will be of American origin.

The only French Firm "to save face" is SMT-Groupil, who received an order for 3470 units. The other French brands, however, received remarkably low orders: Leonard will furnish 664 microcomputers, Bull will supply 525, and Forum will only provide 184.

Ranking after the failures of Matra and Excelvision in 1986, the current big loser is Thomson, who furnished the GOF with 100,000 machines in 1985 but was noticeably absent from this year's list of contact winners. Despite its ambitions, Thompson has never quite made its mark on the European microcomputer scene and has encountered a downward trend by meeting only about one-third of its sales objectives in recent years. (In 1986 Thomson projected sales of 300,000 units but only sold 100,000. In 1987, Thompson projected sales of professional microcomputers to be in the 20,000 to 50,000 range

but only sold 10,000. This year's sales were anticipated at 150,000 microcomputers based on 1986 estimate but Thomson will probably only sell 50,000 units.) Thomson's abandonment of microcomputer sales abroad as well as rumors that they've been curtailing projects in the planning stages indicated to some that Thomson may eventually phase-out microcomputer production. Evidenced by a collapsing market share in France (12.5 percent in 1986 as compared with 7.3 percent in 1987). Moreover, Bull no longer considers the microcomputer industry a strategic priority and is currently assessing the possibility of having its machines manufactured by other companies.

The French microcomputer industry, despite being supported by numerous public purchases in recent years (education, policy, army, postal service) has not been competitive with the rest of the world as demonstrated in comparatively low sales figures (tens of thousands per year versus hundreds of thousands.)

The government's recent move to purchase the majority of microcomputers for the French school system from foreign sources has been read by many as an indictment of severe technological inadequacy in the French industry. While one cannot predict the response to this event it is likely that we will see many more of the type of arrangements that Matra has with Sun systems (US). Matra currently markets Sun products in France, simply replacing the "Sun" label with one of their own in a direct "pass though" process.

France Announces New Group for the Development and Application of Superconductivity Technology. France has recently announced the formation of a group responsible for both the development of superconductivity technology and its commercial application. The group is composed of four Centre Nationale de Recerche Scientifique (CNRS) laboratories and two large industrial conglomerates, Rhone-Poulenc and CGE.

The objective of the group is to develop superconductors for the transport of high current – approximately 1 kA/cm^2 – without resistance and at the temperature of liquid nitrogen.

The participating CNRS laboratories are the Institute of Matter and Radiation (CRISMAT) in Caen, the Laboratory for Solid-State Chemistry in Bordeaux, the Laboratory for Very-Low Temperature Research in Grenoble, and the Laboratory of Crystallography, also in Grenoble.

In addition to funds provided by the two industrial participants, the group will have a budget of FF9 million (approximately $1.5 million) over the next 4 years provided by the French government. This FF9 million budget is strictly for the procurement of equipment and does not include salaries or other laboratory costs.

The group hopes to develop superconductors with commercial application in the areas of magnets, transformers, and electric motors.

The participation of Rhone-Poulenc and CGE suggest that this is a serious effort. This group represents one of the few organized French efforts in material sciences to bring scientific development and industrial application together under the same program. It is also reflective of the new approaches the government and Minister of Research Curien are taking towards research and development.

The Laboratory for Solid-State Chemistry at the University of Bordeaux. The Laboratory for Solid-State Chemistry at the University of Bordeaux (I) is considered by French and foreign scientists, including American, as one of the best in the world. Directed by Jean Etourneau, the laboratory, which is jointly supported by the university and the Centre Nationale de la Recherche Scientifique (CNRS), consists of 14 professors and 13 lecturers from the university, 11 directors of research and 9 research fellows from CNRS, 56 Ph.D. students (22 of whom are foreign), 10 trainees, and 35 engineering, technical, and administrative staff (CNRS). The laboratory does both basic and applied research in solid-state chemistry, materials science and solid-state physics. The laboratory is a member of the new CNRS-industry group on high-temperature superconductivity. It has significant expertise in the area of interfaces and in the preparation of new materials. Also, according to a senior American scientist from the General Electric Corporation, the US "simply cannot do what they are doing here" in research on the chemistry of oxygen at high pressures.

The most renowned laboratory in the Bordeaux complex (there are two other universities in the city, Bordeaux II [Medicine and Pharmacology] and Bordeaux III [Arts and Letters]) is the Laboratory for Solid-State Chemistry. It is jointly funded by CNRS and Bordeaux I. CNRS primarily funds salaries of CNRS Researchers and specific projects. Etourneau, as well as being the Director, is an expert in the preparation of new materials, including ceramics. He is also the group leader of the high-temperature superconductivity effect.

The major foci of the laboratory in basic sciences are:

- Magnetism and magnetic properties of materials
- Transport properties in materials
- Ferroelectric and ferroelastic materials
- Luminescent properties of materials
- Inorganic noncrystalline solids
- Interfaces in composite and ceramic materials
- Crystallochemistry and chemical transitions in solids
- Growth of cyrstalline materials

In applied sciences the foci are:

- Materials applied to electronics (dielectrics, variable resistant materials, semiconductors, chemical detectors)
- Coatings for magnetic recording
- Optical materials: image transmission, light transmission, color dispersion
- Materials for the conversion and storage of energy
- Materials with high mechanical and thermal performance

This strong emphasis on applied science with commercial applications is the wave of the future for CNRS-funded laboratories. Etourneau is an enthusiast in this regard and has had enviable success in collaborating with French industry and with other CNRS laboratories.

The laboratory has had, and continues to have, close ties to the US. In particular, it was the leading French lab in the US/French experiment on the growth of germanium crystals which was carried out in November 1985 aboard the space shuttle Challenger. In June, the lab was hosting two postdoctorates and three senior scientists from the US. Ongoing collaborations exist with General Electric Corporation, AT&T, IBM Yorktown Heights, and Brown, UC Berkeley, Purdue, and Texas (Austin) Universities.

In order to get an objective appreciation for the quality of the work conducted at the laboratory, the Embassy Science Counselor held extensive discussions with Glen A. Slack, a senior scientist with the General Electric research and development laboratory, who was com-

pleting a 2-month visit. Slack advised that GE has been collaborating with this laboratory for over 20 years. Slack, a materials scientist who developed one of the first aluminum-based ceramic materials, stated that, in his view, Etourneau's lab was easily one of the best in the world. Areas of strength are in ceramic materials and new materials development and preparation, especially high temperature superconductors, thin films, interface studies and high-pressure chemistry. Slack stated that, in research on the chemistry of oxygen at high pressures, US labs [to repeat] "cannot do what they are doing here. That is why GE collaborates with them."

This lab is large by French standards. However, funding is limited by US standards and the facilities are not in the best repair, especially as compared with fully funded CNRS labs. However, clearly the scientists at this lab do a tremendous amount of work. They are extremely efficient and imaginative. Knowing where the competition lies (i.e., the US and Japan), they are determined to maintain their "pocket of excellence" in fields related to solid-state chemistry. Their extensive collaborations indicate an openness that is not typical of French labs and may be one of the reasons for the lab's strengths. Whatever the reasons, the Laboratoire de Chimie du Solide is an example of the best France has to offer in scientific research.

Italy

For further information of Italian items, contact Gerald Whitman, Office of the Science Counselor, American Embassy, Rome, APO New York, 09794-0007.

Milan Polytechnic Tests Short Impulse Laser. Researchers at the Institute of Physics and Milan Polytechnic have achieved a new high in laser pulse rates in Italy by developing an organic laser with a 50-femtosecond pulse rate. The laser works by exciting organic molecules similar to those used for dyes. The Italian group developing the laser is headed by Professor Orazio Svelto, in association with a Chinese researcher, Liu Yupu, on loan to the Italian institute. The researchers expect the laser will be useful in testing microelectronic circuits, fiber optics applications, and the study of fast chemical reactions.

Hydroacoustic Control Signals in Underwater Oil Drilling Wells. The Italian company for oil research, AGIP, is testing a method of transmitting hydroacoustic signals for the remote control of underwater oil rigs. The joint research is being carried out with the Italian industries TECNOMARE and Nuovo Pignone, and with the Norwegian firm Konsberg Vaapen Fabrikk. The method, currently being tested in an oil well off Sicily, would eliminate the need for mechanical, hydraulic or electric connections.

Italian Supercomputer for Theoretical Physics. A consortium of the Universities of Rome, Pisa, Bologna, and Padua, in cooperation with CERN in Geneva, have completed development of two prototypes of the Array Processor Experiment (APE) supercomputer. APE, which can handle 250 million operations per second, has 16 coprocessors and 16 memories. A 32-processor, 32-memory machine is expected to be tested by the end of the year. The objective of the consortium is to produce a computer more powerful and less expensive than the Cray.

CNR's New Telescope in Sicily. The Italian National Research Council's (CNR) 32-meter telescope being built in Noto, Sicily, will begin operations in October, according to CNR officials. The radiotelescope is part of the Italian project to establish in Sicily a center for radioastronomy and geodynamic research. The overall cost of the station is about 7 billion lire (about $5 million).

Five-Year Plan for National Institute of Nuclear Physics is Approved. The Interministerial Committee for Economic Programing has approved the 1989-1993 plan for the National Institute of Nuclear Physics, providing 1800 billion lire (about $1.3 billion) financing and the hiring of 400 researchers over the next 5 years. The plan represents a more than 100-percent increase over the previous 5-year period.

Ansaldo Markets Artificial Pancreas. The Ansaldo Electronic Biomedical Section is marketing a 10-kilogram artificial pancreas which monitors glycemic blood levels. Known commercially as "BETALIKE," the device is being evaluated at the Institute of Medical Pathology of the University of Perugia for the possible measurement of lactate, sodium, and potassium levels, as well as simultaneous use for more than one patient.

Padua Inaugurates RFX Nuclear Fusion Laboratory. The Ionized Gas Institute of Padua has completed construction of a new 4-meter toroidal fusion device for plasma studies. The 130-billion-lire (about $100 million) laboratory is sponsored by the EEC's controlled thermonuclear fusion program with financial support from ENEA, CNR, and EURATOM.

Italy and China Approve 52 Joint Industrial Venture Projects. The Italian Association of Industrialists and the Chinese State Agency for the Promotion and Coordination of Industrial Projects (CCBCC) signed in June an agreement for new commercial and industrial ventures with Italian small and medium industries. The agreement outlines 52 projects, including the production of automobile spare parts, leather and shoes, textiles, clothing, light machinery, tractors, and ceramics. The project aims to facilitate export of Italian manufacturing plants and technologies.

Research Consortium Established in Milan. The creation of a new consortium, "Milano Ricerche," was recently announced in Milan for the development of medium- and long-term research projects. The consortium comprises the four Milan universities (Bocconi, Statale, Politecnico, and Cattolica), several industries of the public and private sectors (Italtel, SGS Microelettronica, IBM Italia, Mandelli, Pirelli, Biorad) and the National Institute of Nuclear Physics. The consortium is now concentrating on CAD/CAM systems development and student training in disciplines where there is a shortage of scientists and engineers.

Association of Electronic Industries Reviews Robot Market in Italy. According to ANIE, the Italian National Association of Electronic Industries, the robot market in Italy in 1987 reached 1660 billion lire (about $1.3 billion) in sales, supplying 60 percent of domestic requirements. The robot market is expected to increase 17 percent in 1988.

Italian National Research Council Inaugurates Research Area in Milan. On July 18 the President of the national Research Council (CNR), Rossi Bernardi, inaugurated a new research area as part of CNR's long-term objective to consolidate its 273 research institutes nationwide into 16 major centers. (Research areas already in operation are in Rome, Florence, Pisa, Bologna, and Naples).

The consolidation effort is estimated to cost about 600 billion lire (about $460 million) over 3 years, supplemented by 250 billion lire from the agency for the development of the south for the development of research areas in Naples, Cagliari, Bari, Catania, and Palermo.

The Milan Research Area now hosts:

- The Institute for Cosmic Physics Research
- A laboratory for silicon technology to be operated jointly with the SGS-Thompson industry
- The Institute for Mathematics and Informatics Applications
- The Institute for the Dynamics of Economic Systems
- The Institute for Geophysics
- The Experimental Institute for Machine Tools
- The Institute for Advanced Biomedical Technologies.

The Milan Research Area will concentrate on research in biotechnologies, fine chemicals, fusion technologies, robotics, industrial automation, environment, new materials, and informatics—all in close cooperation with Milan State University, Catholic University, Milan Polytechnic, and the Bocconi University for Economics. The State University and the Milan Research Area are already working together on the construction of a superconducting cyclotron accelerator. In addition the Milan Research Area will also host the "Consorzio Milano Ricerche," a consortium involving CNR and Milan universities and industries, aimed at joint initiatives in the biotechnology, microelectronics, and CAD/CAM programing sectors.

Catania Inaugurates Nuclear Physics Laboratory. The minister of scientific research and the director of the National Institute for Nuclear Physics (INFN) inaugurated "The National Laboratories of the South" in Catania for the research on properties and structures of atomic nuclei. The laboratory is equipped with a 20-Mev tandem heavy ion accelerator which will be joined in less than 1 year by a circular "superconducting cyclotron," presently being built in Milan. The Catania labs, sponsored by INFN and Italian universities, will work with the microelectronics industry on developing an intelligent power transistor through ionic implantation techniques.

Computation Center in Naples. A new computer center is being established in Naples for research on parallel architectures and supercomputers. The center, headed by Professor Carlo Savy of the Department of Informatics of the University of Naples, has initial financing of 16 billion lire (about $12 million) and will employ 22 scientists.

Italian Government Approves Financing for Industry Applied Research. The Italian parliament approved a law allotting 3,750 billion lire (about $2.9 billion) for applied research in industry with special emphasis on small and medium industry and consortia. The sum will be spent over a 10-year period starting with 125 billion lire each year for 1988/89/90 and the remainder to be spent through 1997.

Digital Equipment Opens World Research Center in Varese, Italy. Digital Equipment Corporation (DEC) is opening a software research and development center in Varese, Italy, for the development of base software for DEC systems worldwide. The center, which opens October 1988 and employs 300 scientists, will focus on integration of standard operational systems (such as UNIX/POSIX and VAX/VMS), computer-aided software engineering (CASE), and computer-integrated manufacturing (CIM).

Ansaldo Enters the Robot Era. Ansaldo is entering in the robot business by specializing in multipurpose and special-purpose service robots capable of conducting activities in hazardous environments. Two of these robots (called Portans 1), are already in operation; they are employed to inspect radioactive nuclear components. Another more sophisticated robot, the SMT (Sistema Mobile Telemanipolazione [Remotemanipulation Mobile System] is nearing completion and will be employed in decontamination activities and decommissioning of chemical and other hazardous plants. In addition, Ansaldo is participating with other Italian and EEC industries at two EUREKA projects for the AUR (Advanced Underwater Robot) and the AMR (Advanced Mobile Robot).

Olivetti Markets Voice Computer. Olivetti's "Speech and Language" Laboratory in Turin has developed a new device to tranlate text into voice. Called VOXPC (Voice Option for Personal Computer), the Cost as an optional add-on for personal computers is 1.3 million lire (about $1000). VOXPC can synthesize voice in three different languages (Italian, English, Spanish), and will be used in language teaching, proofreading of texts dictated in the office, electronic mail, and as an aid for the blind. The Olivetti laboratory is also working on a computer voice recognition system with a 10,000-word dictionary in seven different languages.

ENEL Invests in Environmental Protection. The Italian National Electric Company (ENEL) is investing over 5000 billion lire (about $3.8 billion) over 5 years to decrease sulphur emissions from coal-fired power plants. ENEL is also spending 5 billion lire per year for the study of acid rain, for the evaluation of environmental impact of new power plants, and for the research of new processes and devices to limit emission. The ENEL program also includes the start-up in 1991 of a pilot power plant employing high sulphur content coal from Sardinia with new devices to reduce sulphur emissions.

New Interest in the Recycling of Plastic. Thirteen industries responsible for 85 percent of total plastic production in Italy have formed a consortium and funded an Institute for the Utilization and Recycling of Plastic Materials (IVR). The institute is also supported by the plastic-producing machinery manufacturers as well as by ENEA, the National Research Council (CNR), and the ministries of environment and health. IVR will study techniques of collecting, treating and reutilization of plastic waste; build an experimental plant for the recovery and recycle of plastic bottles; and create a data bank drawing from the most advanced waste cycling methods in Europe. The amount of plastic waste in Italy is estimated at 7 percent of the 17 million tons of solid urban waste. An estimated 11 percent is incinerated, 30 percent is deposited at authorized discharge points, 55 percent is deposited in uncontrolled discharge points, and 4 percent pollutes the environment.

Tecnobiomedica Emerges as a Leader in Biotechnology. Technobiomedica, a company founded in 1980, has captured 30-35 percent of Italy's biotechnology market, financing more than 30 new biotechnology industries. Since 1983 the company has spent over 140 billion lire (about $115 million) for 25 research projects in bioimagery, reactive and diagnostic methods, artificial organs, programmable and microprocessor-managed

pacemakers, and cardiac valves. Before 1980 Italy was dependent entirely on sources abroad for biotechnology applications.

New Device Measures Temperature of Internal Organs. The company "Elettronica" of Rome has developed a computerized system, called "ADIR," capable of measuring with precision of one-tenth of a degree centigrade the temperature of any part of the human body through an infrared telethermographic camera. Slight variations of temperature especially in glands permit the early diagnosis of the presence of neoplastic cells – before the cancer is evidenced by the presence of nodules. The simple ADIR method allows the mass screening of patients. Elettronica in cooperation with the National Research Institute of Solid State Electronics has also developed Biomag-1, a biomagnetic system capable of capturing the weak magnetic signals associated with physiological processes of the human organism. Biomag-1 employs highly sensitive superconductor sensors (SQUIDS) which allow more accurate electrocardiograms and electroencephalograms.

United Kingdom

For further information on British items, contact James Devine, Office of the Science Counselor, American Embassy, London, APO New York 09509.

ACOST Report on Optoelectronics. ACOST was established in 1987 to advise the government on priorities for science and technology in the UK. It consists of senior officials from industry and universities and reports to an interministerial committee chaired by the Prime Minister or John Fairclough, the Chief Scientific Adviser to the Cabinet.

While ACOST previously issued a report on the industrial impact of the introduction of pressurized water reactors into the US, this is its first report on science and technology. Totaling 108 pages, the report consists of seven chapters, references, appendices, a glossary, and a list of abbreviations. After the first introductory chapter, the second discusses the conclusions that:

- Any national program should include research into new materials, optical switching systems optical formation processing and storage
- The government improve education and training in optoelectronics
- The UK spend as much on optoelectronics as its international competitors
- UK companies establish alliances with overseas companies in European community programs for collaborative research and development.

Chapter three discusses available markets, with specific discussion of the following areas: communications, information systems, consumer, military, automotive, aerospace, medical, materials processing, process control, safety and security systems, energy, components, and materials. Chapter four describes some of the key technologies which are applicable to a range of markets. These include materials, transmission and switching systems, components for communications systems, optical information processing, optical storage of information, displays, imaging, sensors, and lasers. Chapters five and six, respectively, describe UK government activities and the status of education and training. The final chapter, entitled "Comment," deals with what the report terms common themes which merit discussion in a broader context. These are grouped under the headings of materials, machinery, manpower, money, and markets.

UK Research and Development Expenditures – The Debate Goes On. Total government expenditures on research and development in 1986/87 was little changed from 1985/86, with civil R&D down by 3 percent. Over the period 1986/87 to 1990/91, R&D expenditures (in cash terms) are expected to rise by 9 percent, civil by 12 percent, and defense by 7 percent. However, in real terms (with a base year of 1986/87), total R&D expenditures fell by 3 percent between 1985/86 and 1986/87. Similarly, civil R&D is expected to decline in real terms by 7 percent between 1986/87 and 1990/91. Predictably, these forecasts have buttressed the claims of government critics that the UK science base for research is substantially underfunded. Equally predictably, the government defends its science record by pointing to the 15 percent increase in real terms it has approved since coming to office in 1979. All agree, however, that the average investment by UK industry in R&D is well below other Western nations.

In August, the government issued its *Annual Review of Government Funded Research and Development*. Depending on the frame of reference – cash terms or real terms – in reading this document, UK R&D expenditures are either rising or declining. By either measure civil and defense R&D expenditures are almost equal. The government's projections to 1990/91 by department show, with a couple of minor exceptions, no increases in real terms over the same timeframe. Projections for the research councils show a 5-percent increase in real terms. There will be a cut of about 5 percent in manpower. Nearly 1500 jobs will be lost in the research councils and over 700 in the Ministry of Defence.

Of particular interest to science policy readers is the government's emphasis on measures designed to disseminate R&D results with the aim of more effective commercial exploitation (what the British call "technology transfer"). For example, the Department of Trade and Industry (DTI) considers the encouragement of technology transfer and cooperative research as perhaps its principal objective. To that end, DTI has announced that its policy is now focused primarily on circumstances where research is necessary before commercial applications can be developed, or where the benefits of the research are likely to be widespread. Among the mechanism DTI is employing to achieve its objective are the so-called Link programs, which are designed to foster collaboration among companies, universities, and research councils, and the EUREKA programs. DTI is also giving priority to EC programs that have the greatest industrial relevance, e.g., RACE (telecommunications), ESPRIT (information technology), BRITE (industrial technologies), and EURAM (advanced materials). Similarly, the science and engineering research council (SERC) has dramatically shifted its emphasis over the years from "big science" areas such as nuclear physics and astronomy toward "small science" (in the words of the annual report) and engineering. "Focused research of practical importance" are SERC's current buzz words.

It goes without saying that the government's emphasis on value for money has not gone down well with the science lobby, which includes the Royal Society, the British Association for the Advancement of Science, and the Advisory Board for the Research Councils (ABRC). Sir George Porter, Britain's most eminent scientist and President of the Royal So-

ciety, recently called on the government to provide £27 million ($46 million) for small grants to individual research workers, to fund research in the core sciences, and to reverse the current trend whereby the "meager funds allotted to basic research in the core sciences are raided yet again." In his presidential address to the British Association for the Advancement of Science on September 5, Sir Walter Bodner observed: "My frustration, shared, I believe, by most scientists, is that now, when science is better placed than ever before to contribute to a better future, we are having to struggle increasingly hard to prevent a damaging decline in government support for fundamental science," and Sir David Phillips, Chairman of the ABRC, recently called for an additional £200 million ($340 million) over the next 3 years for such areas as computer science, quantum optics, the human genome, and atmospheric and marine pollution. Referring to the shortage of researchers, Phillips said the situation is "absolutely frightening." For its part, the government asserts that its record of funding research has been "very good" in the words of Kenneth Baker. Baker, Secretary of State for Education and Science, noted that since Mrs. Thatcher took office in 1979, government expenditures on R&D have risen 15 percent in real terms. From all of this one can draw two conclusions: the chances of significant increase in the UK budget for research and development are virtually nil for the foreseeable future and scientists will continue to complain bitterly about it.

West Germany

For further information on West German items, contact Edward M. Malloy, Office of the Science Counselor, American Embassy, APO New York 09080

Center for Artificial Intelligence. On 5 July 1988 Minister Riesenhuber of West Germany's Federal Ministry for Research and Technology (BMFT) signed the contract for the establishment of a German research center for artificial intelligence (Deutsches Forshungszentrum für Kuenstliche Intelligenz [DFKI]) to be located at Kaiserslautern with a subsidiary at Saarbruecken. Cofounders of the center are the Federal Government, the state governments of Rhineland-Palatinate and the Saarland, the Universities of Kaiserslautern and Saarbruecken, nine information technology institutions, and the two large-scale science institutions – the Frauenhofer Society and the Society for Mathematics and Data Processing. The center will be financed jointly by its founders, with government support guaranteed for a period of 10 years. Its purpose is to carry out fundamental research in the key technologies relating to artificial intelligence and to promote the transfer of such technologies into industrial applications. Since 1984 the BMFT and industry have cofunded research with approximately DM300 million (about $161 million).

Laser Tooth Drill. Scientist of the University of Bonn have developed a tooth drill for pain-free dental treatment using the ultraviolet light of an argon-fluoride-gas laser. With the help of the intensive laser light, a so-called photoablation is reached to dissolve chemical bonds in the tooth substance. This technique helps to avoid painful mechanical irritations and to reduce heat production, both inherent in tooth drilling. The laser treatment of the tooth enamel leaves extremely adhesive surfaces and thus avoids the smear-layer connected with the conventional water-cooled drilling method which may reduce the durability of fillings.

Element 109. In early February, a research team under the leadership of Professor P. Armbruster of the Society for Heavy Ion Research (Gesellschaft für Schwerionenforschung [GSI]) at Darmstadt was able to again generate the superheavy element with the atomic number 109. GSI has achieved a worldwide leading position with the discovery of the heaviest atoms to date: elements with atomic numbers 107, 108, and 109. For the repeated generation of element 109, which was required for its inclusion in the periodic system of elements, 2,000 billion atomic nuclei per second of iron (atomic number 26) were shot at bismuth nuclei (atomic number 83) in the heavy ion accelerator UNILAC at GSI. After 5 days the two nuclei melt into element 109.

Thin Coating Technology. Increased support will be given to the development of new procedures for surface and fine coating technologies under the Federal Ministry for Research and Technology (BMFT) budget beginning in 1988. The increase raises funds for coating technologies from DM36 million to DM69 million ($19.5 to $37 million). In order to promote the competitiveness of West German industry in this field. Cooperative research institutions with industry are to be supported in the following areas: (1) research on procedures for vacuum plasma, and ion-beam-supported fine coating production and modification; (2) chemical vapor deposition (CVD) procedures; and (3) combinations of different technical procedures for fine coating.

Computer Integrated Manufacturing (CIM) Technology. For its program "production technologies," the BMFT has earmarked DM502 million (about $270 million) for the period 1988 to 1992. Under this program, support measures concentrate on two priorities: computer-integrated manufacturing (CIM) and new production technologies (NPT). The major objective of the program is the promotion of CIM technology transfer, standardization in the field, and its applications for small and medium-sized enterprises. Leading work is being done at the University of Stuttgart, where a special Institute for Computer Screen Technology (Bildschirmtechnik) has been established, and by the Fraunhofer Institute for Production Technology and Automation (Institut für Produktionstechnik und Automatisierung [IPA]), also at Stuttgart.

Emission Control Status Report. According to the 4th Emission Control Status Report (Immissionsschutz-Bericht), some types of air pollution in West Germany have been reduced to 1920 levels. The report, published by the Federal Environment Ministry, claims the reduction successes are due to emission control legislation. Sulfur dioxide emissions, for example, were reduced from 2.9 million tons in 1982 to 2.0 million tons in 1988 and are expected to be further cut to 1.0 million tons by 1995, equivalent to the 1895 level. This is attributed mainly to the reduction of sulfur in heating oil and diesel fuels. During the period 1983-1986, the federal government promoted 450 projects in air pollution, focusing largely on forest damage and climate change, with a total expenditure of DM370 million ($199 million).

Wall Protection for Fusion Installations. A new procedure to prevent the pollution of plasma in test installations for nuclear fusion has recently been tested in the fusion machine, Textor, of the nuclear research installation at Julich. During an experiment designed to generate a thin

layer of borane and carbon the research scientists – through a glow discharge ignition of diborane, methane, and helium – obtained a wall protection layer of one twenty-thousandths of a millimeter thick. Although the diffusion of carbon into the plasma could not completely be avoided, tests with the Textor machine revealed that no metals were released from the wall into the plasma. The new procedure was developed for Textor in cooperation with the University of Zurich.

Recycling Procedure for Plastic Wastes. The Ford Motor Company of Cologne, in partnership with the Technical University of Aalen, will introduce a pilot project for the reprocessing of plastic waste materials. The process, developed at the Technical University, provides for the decomposition of polyurethane waste materials left over during the production of seat covers and upholstery as well as the foaming of automotive body parts. According to Ford, waste reprocessing permits the production of solid and skeleton foam which is up to 30 percent cheaper than newly produced material.

Solar-Powered Hydrogen Installation. A solar-powered hydrogen production installation is being established by the Bayernwerk AG at Neunburg Vorm Wald (Oberpfalz). The pilot installation will combine all transformation processes required for hydrogen energy production in one place. The cost for the first project phase – approximately DM65 million ($35 million) – will be borne by Bayernwerk AG (60 percent) and the firms BMW, Linde, MBB, and Siemens (10 percent each.)

Waste Water Treatment. A new procedure for the economical processing of household waste water has been developed at the nuclear research center at Karlsruhe. Through recovery of phosphates, it is expected that very low phosphate concentrations (less than 1.5 milligram per liter) can be achieved, and at extremely favorable cost: approximately 5 pfennings ($0.025) per cubic meter. The Karlsruhe procedure permits the recovery of phosphates contained in waste water in the form of calcium phosphate, a fertilizer, and prevents the salinization of water as well as the formation of toxic sludges. West Germany imports 600,000 tons of phosphate annually. The new procedure would reduce import requests by almost 68,000 tons. After a successful test phase the procedure will be used in a demonstration project in a Berlin wastewater treatment plant.

Transrapid: German Maglev Train to Make Debut. Transrapid (TR) is a high-technology magnetic-levitation (Maglev) train being developed in the Federal Republic of Germany primarily for the export market. Officials here hope to win lucrative American, Saudi Arabian, and southeast Asian contracts based on the successful application of the design in Germany itself. Possible American routes for this technology being discussed among experts in West Germany include Las Vegas to Los Angeles (potential cost: $2.5 billion), Pittsburg to Harrisburg, and Miami to Orlando.

In furtherance of its export hopes, the Federal Ministry of Research and Technology (BMFT) has invested more than DM1.2 billion ($666.7 million [DM1.80 = $1.00]) in the train's development. The parliamentary working group "Transrapid" has formally recommended to the government that a fully operational TR route between Hamburg and Hannover be built to prove its feasibility as a public transporation system. Although government officials point with pride to the fact that industry has participated in the development costs, compared to the overall R&D costs this contribution has been modest at best (DM120 million).

Experts had argued that the best such route would be one in the densely populated region between Cologne and Frankfurt. It was hoped that this solution would supplement the traditional Bundesbahn (German National Railway System) in this area. The Cologne/Frankfurt route was heavily opposed by the Transportation Ministry, which is responsible for the Bundesbahn. They argued that this route would take passengers away from one of their few profit-making routes and drive the Bundesbahn even further into the red. (Approximately DM4 billion in 1987.) TR, they argued, would also compete with the ministry's own high-speed line, the ICE (inter-city express). The ICE, scheduled to come on line years before TR, is similar to the French TGV; it utilizes refined wheel/track technology to achieve its high speeds. Whereas TR has achieved 413 km/h in a test environment, the ICE is close on its wheels with a peak speed of 407 km/h.

The TR is characterized by contact-free, frictionless and therefore nonwearing support and guidance system. This technology works by means of controlled electromagnets. TR's propulsion and braking system operate by means of a contactless and nonfrictional synchronous long-stator linear motor. In the case of the long-stator technique, the travelling-wave-generating coils are integrated into the guideway. The reaction part of the linear motor consists of controlled electromagnets in which an eddy-current is generated in reaction with the current-conducting stator. These electromagnets are installed on both sides of the vehicle. The linear generator is so designed that the power needed for the supporting and guiding system becomes available at about 85 km/h. At lower speeds, the power transferred is inadequate. At this stage, the vehicle is powered by buffer batteries, which can be recharged at speeds higher than 125 km/h.

The basic components of the linear drive are the short-stator and the long-stator linear motors which are both derived from the conventional electric motor. The novelty of this technology is that the rotation of the rotor in a conventional electric motor, caused by electromagnetic forces between rotor and stator is now transformed into a longitudinal movement by arranging the formerly circular rotor and stator elements into a planer system. Two different stator systems have been developed utilizing this principle: the short-stator and the long-stator linear motor. Although the short-stator system is cheaper, the TR uses the long-stator system because of its absolutely fricitionless operation and therefore its better applicability for high speeds. Admittedly, the short-stator technique could also be considered for short distance/lower speed applications.

The TR-0611 prototype (two passenger cabin configuration) technical data is:

- Propulsion system – synchronous linear motor
- Maximum thrust – 84 kN
- Aerodynamic drag at maximum speed 400 km/h – 37 kN
- Acceleration capacity – approximately 10 MW
- Maximum acceleration- – 0.8 m/s^2
- Maximum motor voltage – 4250 volts
- Maximum motor power – 1200 amps
- Motor frequency – 0-215 Hz

- Support magnets – 32 per passenger-cabin segment
- Guidance magnets – 28 per passenger-cabin segment
- Length of support and guidance magnet – 1.5 m, independently suspended and decentrally controlled;
- Air gap between guideway and vehicle – 10 mm-2 mm
- Length of stator segments – 300-2800 m
- Passenger capacity – 196 passengers
- Total length – 54.2 m
- Gross weight – 122 tons
- Payload – 20 tons
- Maximum design speed – 400 km/h
- Maximum speed reached – 412.6 km/h.

A test facility has been constructed for testing of the TR-06. The Transrapid Versuchsanlage Emsland (TVE), located at Lathen in the State of Lower Saxony (close to the Dutch border), is 31.5 km in total length. It consists of an almost straight section on the flat of approximately 10 km, a northern loop with a curve radius of 1,690 m and a southern loop. The TR-06 can reach its top speed of more than 400 km/h over a distance of about 1,200 m.

The revenue picture is clouded by a number of factors. The tremendous expense of the system will require high fares, thus limiting the number of potential users of the system. TR is billed as filling the gap between rail and air travel. Whether it will be able to compete with air fares is not certain. Government subsidies may be required to create the competitive edge. The system will have limited freight-carrying capabilities; the sensitivity of TR to load changes – it can only handle lighter freight items – severely compromises its usefulness as a freight train. Freight income will therefore be less important than passenger income.

The government has been working with a consortium of 15 firms under the leadership of Thysson Henschel AG to develop TR. Other partners include Krauss-Maffei AG and Messerschmitt-Bölkow-Blohm GMBH. Criticism of the Hamburg-Hannover route has also come from the consortium, according to Spiegel. They would have preferred the Cologne-Franfurt route in terms of its better profitability.

The costs of the chosen route, which is 153 km long, is between DM2 and 3 billion (about $1.1 billion and $1.66 billion). The government's figures for construction costs are in dispute, as is the source of these funds. Interagency wrangling concerning how the developmental and construction costs of the test stretch will be distributed among the government and private sector partners is not yet resolved.

Government-Industry Program in Advanced Ceramics Research. As part of a 10-year (1985-1994) plan for supporting materials research, the Federal Ministry of Research and Technology (BMFT) has committed itself through 1986 to fund over half the cost of 52 research projects in advanced ceramics. Carrying out the research projects and accounting for up to half their costs are some of Germany's leading firms and institutes. Daimler-Benz is developing and testing the use of advanced ceramics for building automotive parts. Hoechst and Hutschenreuther are working on parts for gas turbines. Felmuehle is studying the use of ceramics in gaskets and bone implants. The Max-Planck-Institute for Metal Research in Stuttgart is developing ceramic materials able to withstand high temperatures and stresses. The Fraunhofer Institutes of Nondestructive Material Testing, Production Technology, and Material Mechanics work on quality assurance of ceramic components in mass production.

Ceramics in only one of the five priority areas in the BMFT's materials research program. The other four are powder metallurgy, metallic high-temperature materials, compound materials, and polymers. Through 1986, the BMFT has agreed to fund 384 projects valued at $500-$600 million. Coordinating this program for the BMFT is the materials research group in the Nuclear Research Center in Julich. In addition to advancing materials research, the program aims at promoting research cooperation between industry and research institutes. For example, Hoechst Ceramtech is developing ceramic construction elements of a gas turbine in cooperation with the subcontractors Daimler-Benz, the technical universities in Karlsruhe and Berlin, and the German Aerospace Research Establishment (DFVLR). Hutschenreuther as main contractor and the Fraunhofer Institute of Non-Destructive Material Testing, as subcontractor, are jointly developing manufacturing processes and technologies for ceramic components.

OVERSEAS TRAVELERS

Notes on trip reports to locations in Europe and the Middle East which have been received by ONRL are reported below. For details, contact the traveler directly.

Electronics

Traveler: E.E. Barr of Code 5551, Information Technology Division, Naval Research Laboratory, Washington, DC 20375-5000.

Mr. Barr attended the Fourth International Conference on HF Radio Systems and Technology held in April 1988 at the Institution of Electrical Engineers in London, UK. The conference organized by the Electronics Division of the Institution of Electrical Engineers was attended by more than 260 scientists of diverse backgrounds including mathematicians, physicists and engineers. The attendees were from at least 23 countries with the majority from Western Europe and with smaller delegations from Eastern Europe, the Middle East, Far East, and North America.

The over 80 papers presented covered the HF area and were broken up into sessions entitled System Design Control and Networking; Antennas; Noise; Interference, and Modeling; Propagation; RF Equipment and Techniques; HF Radar, and Signal Design and Processing. In general, the papers presented in the sessions were topical, interesting, and well attended.

Mr. Barr's paper, entitled Low Distortion RF Component Technology Development, was presented in one of the

RF equipment and techniques sessions. This paper discussed investigations in ferrous materials performed by the Westinghouse Electric Corporation under the guidance and specifications of the Naval Research Laboratory. This paper briefly reviewed the approach used to meet the performance requirements by first discussing the initial investigations into available ferrous materials, then presented three design techniques used to fulfill the requirements, and finally, focused on the performance of a representative sample of the components delivered by Westinghouse to the Navy.

The conference proceedings have been published and were made available at the conference. For further information contact the Institute of Electrical Engineers, Savoy Place, London WC2R OBL, United Kingdom.

Materials Science

Traveler: Dr. Clive R. Clayton, Department of Materials Science and Engineering, State University of New York at Stony Brook, Stony Brook, New York 11794-2275.

Dr. Clayton attended the first International Conference on High Nitrogen Steels (HNS 88), which was held at the Palais des Congres, Lille, France, May 18-20, 1988. Organized by the Société Francaise de Métallurgie and the UK's Institute of Metals, it was attended by more than 130 delegates from 19 countries, and attracted 83 papers.

The papers covered four main topics which Clayton briefly reviews:

(1) Fundamental studies, (2) Manufacture of nitrogen-containing alloys, (3) Mechanical properties, (4) Chemical and electrochemical behavior.

In Fundamental studies, Professor Mats Hillert of the Royal Institute of Technology, Stockholm, Sweden, presented a paper coauthored with Dr. Karin Frisk, which was on the thermodynamic modeling of the Fe-Cr-Ni-N system. The paper outlined the need and the methodology for generating a self-consistent data base for the lower order nitrogen binary and ternary alloy systems constituent of the complex Fe-Cr-Ni-N quarternary. Hillert stressed the need to foster further international cooperation in order to develop and assess such data and make it available via on-line computers to those interested in calculating phase diagrams or parts of phase diagrams.

Concerning the Manufacture of Nitrogen-Bearing Alloys, Dr. Gerald Stein (coauthors, Joachim Menzel and Horst Dorr of Schmiedewerke, Krupp-Klockner GmbH, Essen) presented a paper entitled "Industrial Manufacture of High-Nitrogen Alloyed Steels." Stein presented an outline of the fundamental aspects of the Pressurized Electroslag Remelting (ESR) process and the experience his company has gained in hot-forming and joining of nitrogen-containing austenitic and ferritic steels produced by ESR. The main benefit of the ESR process is the ability to produce steel alloys with nitrogen contents up to three times higher than the nitrogen stability limit at atmospheric pressure, resulting in improvements in strength and corrosion resistance. In a paper by N. Holzgruber (Inteco GmbH, Bruck, Austria) an historical review of the methods of producing high-nitrogen steels was presented along with a discussion of the problems associated with the uniformity of the distribution of nitrogen in large quantities of liquid metal. A pressure casting chamber was described which enables 20,000 kg ingots and castings to be produced which utilizes a consumable electrode which is remelted under a high pressure of nitrogen. The technique was reported to ensure controlled solidification and a uniform distribution of nitrogen.

Professor M.O. Speidel (Swiss Federal Institute of Technology, ETH-Zentrum Zurich, Switzerland) in his paper, "New High Nitrogen Steels," presented evidence of the marked benefits of increasing the nitrogen concentration on both mechanical properties and corrosion resistance. Numerous current and potential applications of the new high nitrogen steels were discussed.

The conference also considered surface nitriding by plasma and conventional gaseous techniques. Professor M. Gantois from Ecole des Mines, Nancy, provided a review: "Trends in Plasma Nitriding, Metallurgy and Processing" in which methodology and benefits of the technique were comprehensively outlined.

Speaking on the topic of mechanical properties, Professor F.B. Pickering of Sheffield Polytechnic (UK) provided a very comprehensive overview of the influence of nitrogen on physical metallurgical phenomena. He first reviewed the solid and liquid solubility of nitrogen, the interaction of nitrogen with lattice defects, and the influence of nitrogen on transformations, stacking fault energy, work hardening, grain size control, precipitation effects, and weldability. The general mechanical properties of nitrogen-alloyed low-carbon ferritic and pearlitic microalloyed steels was then treated followed by a discussion of the influence of nitrogen on the mechanical properties of austenitic stainless steels. Clayton is convinced that Pickering's paper will become required reading for anyone involved in this branch of steel working.

On chemical and electrochemical behavior, J.E. Truman (Forgemasters Engineering, Sheffield, UK) presented a comprehensive review of the influence of nitrogen alloying on corrosion behavior. The presentation included discussion of martensitic, ferritic, austentitic and duplex stainless steels. The paper presented numerous examples in which nitrogen alloying rendered improvements in resistance to a broad range of corrosive conditions including pitting, crevice corrosion, and stress corrosion cracking. The discussion concluded that nitrogen was most beneficial for increasing the corrosion resistance of austenitic and duplex stainless steels, especially improving the resistance to pitting and corrosion fatigue.

In his conclusion, Clayton says the conference left him extremely impressed with the quality and breadth of this relatively new field of steel making. The new high-nitrogen steels appear to offer some very new exciting possibilities for the future application to a variety of new and traditional industries. He adds that the field appears to be dominated by excellent commercial and government research centered in Europe. The notable absence of contributions by US steel members to the development of high-nitrogen stainless steels was disappointing. Clearly this is an area, Clayton says, where federally funded research could stimulate industry-university collaborative research before an important new market for steels is fully realized.

Traveler: Dr. A.J. Sedriks, Materials Division, Office of Naval Research, Arlington, Virginia, 22217-5000.

Dr. Sedriks attended the 8th Inter-Naval Corrosion Conference, which em-

phasized new technology. This conference, held every 4 years, enables Navy researchers and engineers from the US, Canada, Australia, New Zealand, and the UK to present, gather, and compare corrosion control information and to identify new Navy-oriented research needs. This year the conference was held on 11-15 April, 1988, at the Royal Naval Engineering College, Plymouth, UK, and encompassed new technologies associated with coatings, cathodic protection, copper alloys, stainless steels and nickel alloys, composites, rapidly solidified materials, chlorination, computerized expert systems for coating selection, and ripple-load cracking prediction. The US Navy was represented by speakers from NRL, DTRC, NAVSSES-Philadephia, NAVSEA, NCEL-Port Hueneme, NUSC-New London, and ONR. For the latter, Sedriks presented a lecture entitled "New Stainless Steels for the Marine Environment." Other ORN-sponsored work presented comprised ripple-load cracking (NRL), corrosion of composites (DTRC), and the use of computers in corrosion analysis (NUSC).

Traveler: Dr. Joseph A. Corrado, Code 1702, David Taylor Research Center, Bethesda, Maryland 20084.

Dr. Corrado attended the conference, Computer Aided Design in Composite Material Technology, CADCOMP 88, held in April 1988 at Southampton, UK. He says that the conference papers made clear that there is a great deal of development work being pursued in Europe in the area of composite materials and structures. This is especially true, he says, for the universities. Most of the papers given at the conference were of high quality and slanted toward analytical investigations with the inclusion of some small-scale experimental work.

The conference was organized into seven sessions:

- Laminated analysis and design
- Structural behavior and identification
- Thermal analysis
- Software for composite material technology
- Computer-simulation/filament-winding/manufacturing-processes
- Impact and wave propagation.

Corrado provides brief comments on selected papers from all seven sessions, and encloses a complete list of the papers given. A copy of the proceedings may be available from Corrado for review. Interested readers should inquire.

Ocean Sciences

Traveler: Dr. Steven G. Ackleson, Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, Maine 04575.

Dr. Ackleson attended the Ecology of the North Sea Conference, held in May 1988 at the Netherlands Institute for Sea Research, Textel, the Netherlands, where he presented a paper entitled "Bio-Optical Classification of North Sea Phytoplankton in Relation to Satellite-Derived Water Masses." The meeting was well attended (over 250 total) by European scientists from a variety of backgrounds with research interests in the North Sea.

In discussions with people at the conference, Ackleson learned that two institutions within the Netherlands are presently developing sea-going flow cytometry laboratories (the Netherlands Institute for Sea Research (NIOZ) and the Tidal Water Division (TWD). NIOZ recently purchased a Culter EPICS C flow cytometer, which is optically identical to the EPICS flow cytometers presently operated by Bigelow Laboratory and the Plymouth Marine Laboratory, Plymouth, UK. M. Veldhuis is currently heading the NIOZ flow cytometry program. TWD is having several multiple-wavelength flow cytometer built (up to three excitation wavelengths operating simultaneously) which will measure forward-angle light scatter, side scatter, and several bands of fluorescence. The contact here was J.C.H. Peeters; J. Visser, and M.S. Dubelaar are directly involved in the TWD flow cytometry program but they did not attend the symposium. Other contacts at TWD In relation to flow cytometry are B.A. Bannink and F. Colijn.

Ackleson says he arrived at two conclusions during the conference: (1) that flow cytometry is no longer a technique in search of an application within ocean science and (2) that the European research community as a whole is much more excited about the potential of flow cytometry in ocean optics than are US researchers. By this time next year, the combined effort of the countries bordering the North Sea, an area the size of New England, will have between 5 and 7 sea-going flow cytometers of sophistication equal to or greater than the Coulter EPICS series of instruments. (The Plymouth Marine Laboratory, Plymouth, UK has been operating a shipboard flow cytometry laboratory, built around a Coulter EPICS instrument, for better than a year now.) At present the US operates only one such sea-going instrument (Mary-Jane Perry, PI, University of Washington). Ackleson believes that ocean optics research within the US, a significant portion of which is sponsored by ONR programs, would benefit greatly by a second sea-going flow cytometry laboratory to be stationed on the east coast in support of of regional research operations.

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